Arm-based Computer Linux User's Manual for Debian 9

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1

Introduction

This user manual is applicable to Moxa's Arm-based computers listed below and covers the complete set of instructions applicable to all the supported models. Detailed instructions on configuring advanced settings are covered in Chapter 3 and Chapter 4 of the manual. Before referring to sections in these chapters, confirm that the hardware specification of your computer model supports the functions/settings covered therein.

Moxa's Arm-based Computing Platforms:

- UC-2100 Series
- UC-2100-W Series
- UC-3100 Series
- UC-5100 Series
- UC-8100 Series (firmware V3.0.0 and higher)
- UC-8100-ME-T Series (Moxa Industrial Linux/Debian 9 preinstalled)
- UC-8100A-ME-T Series
- UC-8200 Series
- UC-8410A Series (Moxa Industrial Linux/Debian 9 preinstalled)

Moxa Industrial Linux

Moxa Industrial Linux (MIL) is the optimized Linux distribution for Industrial applications and users, which is released and maintained by Moxa.

The MIL is based on Debian and integrated with several feature sets designed for strengthening and accelerating user's application development as well as ensuring the reliability of system deployment.

Furthermore, the major versions of MIL comply with Moxa's Superior long term support (SLTS) policy. Moxa will maintain each version of the MIL for 10 years from its launch date. The extended support (ES) may also be purchased by request for additional maintenance. This makes MIL an optimal choice as a Linux operating system for industrial applications.

2

Getting Started

In this chapter, we describe how to configure the basic settings Moxa's Arm-based computers.

The following topics are covered in this chapter:

Connecting to the Arm-based Computer

You will need another computer to connect to the Arm-based computer and log on to the command line interface. There are two ways to connect: through serial console cable or through Ethernet cable. Refer to the Hardware Manual to see how to set up the physical connections.

The default login username and password are:

Username: **moxa**
Password: **moxa**

The username and password are the same for all serial console and SSH remote log in actions. Root account login is disabled until you manually create a password for the account. The user **moxa** is in the **sudo** group so you can operate system level commands with this user using the **`sudo`** command. For additional details, see the *Sudo Mechanism* section in Chapter 5.

ATTENTION

For security reasons, we recommend that you disable the default user account and create your own user accounts.

Connecting through the Serial Console

This method is particularly useful when using the computer for the first time. The signal is transmitted over a direct serial connection so you do not need to know either of its two IP addresses in order to connect to the Arm-based computer. To connect through the serial console, configure your PC’s terminal software using the following settings.

Serial Console Port Settings	
Baudrate	115200 bps
Parity	None
Data bits	8
Stop bits	1
Flow Control	None
Terminal	VT100

Below we show how to use the terminal software to connect to the Arm-based computer in a Linux environment and in a Windows environment.

Linux Users

NOTE These steps apply to the Linux PC you are using to connect to the Arm-based computer. Do NOT apply these steps to the Arm-based computer itself.

Take the following steps to connect to the Arm-based computer from your Linux PC.

1. Install **minicom** from the package repository of your operating system.

   For Centos and Fedora:

   ```
   user@PC1:~# yum -y install minicom
   ```

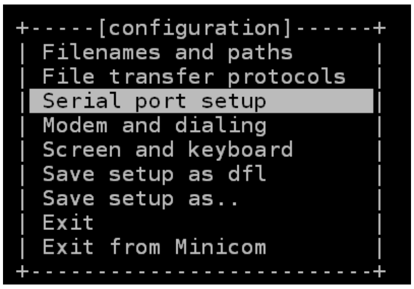
   For Ubuntu and Debian:

   ```
   user@PC2:~# apt-get install minicom
   ```

2. Use the **`minicom -s`** command to enter the configuration menu and set up the serial port settings.

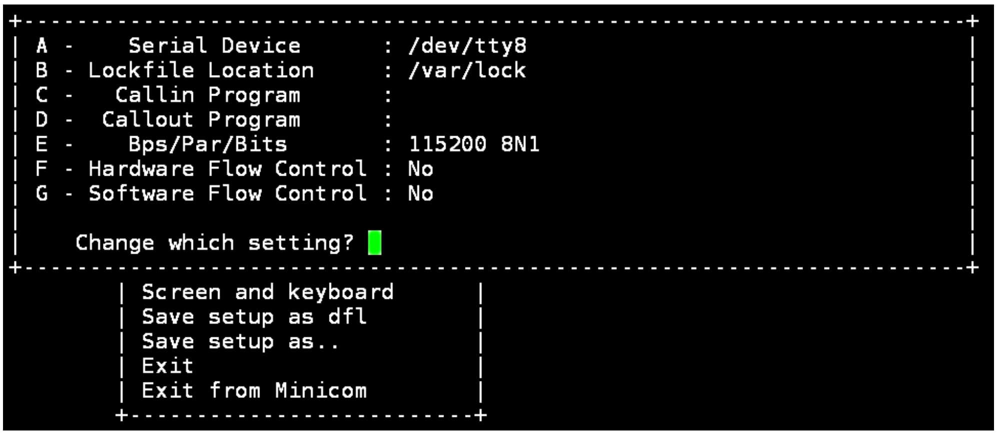
   ```
   user@PC1:~# minicom -s
   ```

3. Select **Serial port setup**.



```
+-----[configuration]------+
| Filenames and paths      |
| File transfer protocols  |
| Serial port setup        |
| Modem and dialing        |
| Screen and keyboard      |
| Save setup as dfl        |
| Save setup as..          |
| Exit                     |
| Exit from Minicom        |
+--------------------------+
```

4. Select **A** to change the serial device. Note that you need to know which device node is connected to the Arm-based computer.



```
+-----------------------------------------------------------------------+
| A -    Serial Device      : /dev/tty8                                  |
| B - Lockfile Location     : /var/lock                                  |
| C -   Callin Program      :                                            |
| D -  Callout Program      :                                            |
| E -    Bps/Par/Bits       : 115200 8N1                                 |
| F - Hardware Flow Control : No                                         |
| G - Software Flow Control : No                                         |
|                                                                        |
|    Change which setting?                                               |
+-----------------------------------------------------------------------+
        | Screen and keyboard      |
        | Save setup as dfl        |
        | Save setup as..          |
        | Exit                     |
        | Exit from Minicom        |
        +--------------------------+
```

5. Select **E** to configure the port settings according to the **Serial Console Port Settings** table provided.
6. Select **Save setup as dfl** (from the main configuration menu) to use default values.
7. Select **Exit from minicom** (from the configuration menu) to leave the configuration menu.
8. Execute **minicom** after completing the above configurations.

```
user@PC1:~# minicom
```

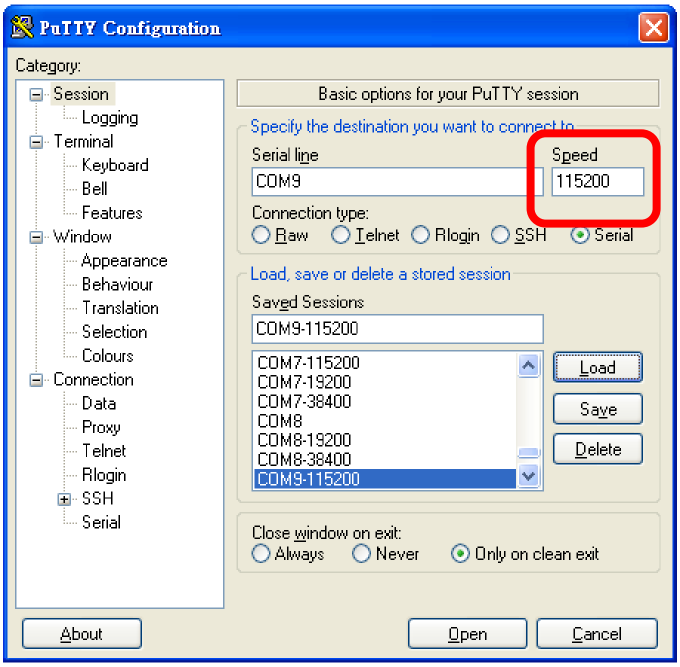
Windows Users

NOTE These steps apply to the Windows PC you are using to connect to the Arm-based computer. Do NOT apply these steps to the Arm-based computer itself.

Take the following steps to connect to the Arm-based computer from your Windows PC.

1. Download PuTTY http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html to set up a serial connection with the Arm-based computer in a Windows environment. The figure below shows a simple example of the configuration that is required.

2. Once the connection is established, the following window will open.



Serial line: COM9

Speed: 115200

Connection type: ○ Raw ○ Telnet ○ Rlogin ○ SSH ● Serial

Saved Sessions: COM9-115200

COM7-115200
COM7-19200
COM7-38400
COM8
COM8-19200
COM8-38400
COM9-115200

Close window on exit: ○ Always ○ Never ● Only on clean exit

3. Select the **Serial** connection type and choose settings that are similar to the Minicom settings.

Connecting via the SSH Console

The Arm-based computer supports SSH connections over an Ethernet network. Use the following default IP addresses to connect to the Arm-based computer.

Port	**Default IP**
LAN 1	192.168.3.127
LAN 2	192.168.4.127

Linux Users

NOTE These steps apply to the Linux PC you are using to connect to the Arm-based computer. Do NOT apply these steps to the Arm-based computer itself. Before you run the **ssh** command, be sure to configure the IP address of your notebook/PC's Ethernet interface in the range of 192.168.3.0/24 for LAN1 and 192.168.4.0/24 for LAN2.

Use the **ssh** command from a Linux computer to access the computer’s LAN1 port.

```
user@PC1:~ ssh moxa@192.168.3.127
```

Type **yes** to complete the connection.

```
The authenticity of host ‘192.168.3.127’ can’t be established.
RSA key fingerprint is 8b:ee:ff:84:41:25:fc:cd:2a:f2:92:8f:cb:1f:6b:2f.
Are you sure you want to continue connection (yes/no)? yes_
```

ATTENTION

Rekey SSH regularly

In order to secure your system, we suggest doing a regular SSH-rekey, as shown in the following steps:

When prompted for a passphrase, leave the passphrase empty and press enter.

```
moxa@Moxa:~$ cd /etc/ssh
moxa@Moxa:~$ sudo rm -rf
ssh_host_ed25519_key2      ssh_host_ecdsa_key      ssh_host_rsa_key
ssh_host_ed25519_key.pub  ssh_host_ecdsa_key.pub   ssh_host_rsa_key.pub

moxa@Moxa:~$ sudo ssh-keygen -t rsa -f /etc/ssh/ssh_host_rsa_key
moxa@Moxa:~$ sudo ssh-keygen -t dsa -f /etc/ssh/ssh_host_dsa_key
moxa@Moxa:~$ sudo ssh-keygen -t ecdsa -f /etc/ssh/ssh_host_ecdsa_key
moxa@Moxa:~$ sudo /etc/init.d/ssh restart
```

For more information about SSH, refer to the following link.

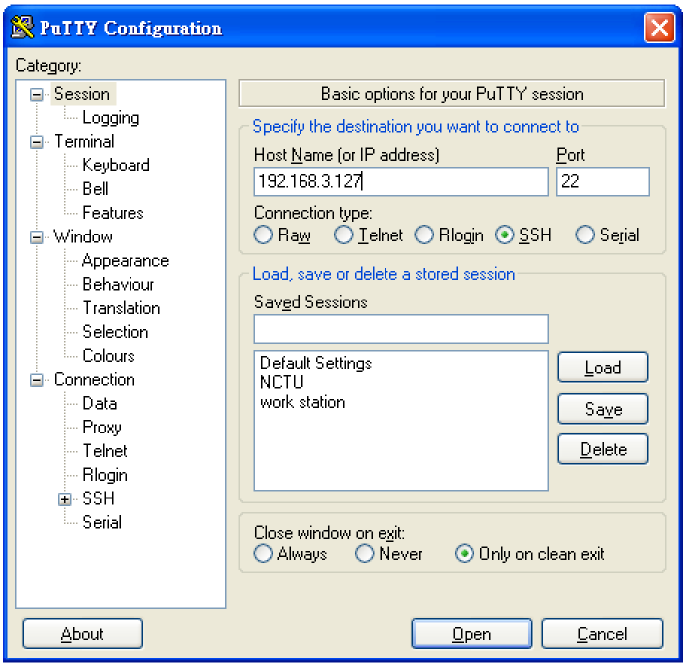
https://wiki.debian.org/SSH

Windows Users

NOTE These steps apply to the Windows PC you are using to connect to the Arm-based computer. Do NOT apply these steps to the Arm-based computer itself.

Take the following steps from your Windows PC.

Click on the link http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html to download PuTTY (free software) to set up an SSH console for the Arm-based computer in a Windows environment. The following figure shows a simple example of the configuration that is required.



PuTTY Configuration

Basic options for your PuTTY session

Specify the destination you want to connect to

Host Name (or IP address): 192.168.3.127

Port: 22

Connection type: ○ Raw ○ Telnet ○ Rlogin ● SSH ○ Serial

Load, save or delete a stored session

Saved Sessions:

Default Settings
NCTU
work station

Close window on exit: ○ Always ○ Never ● Only on clean exit

User Account Management

Switching to the Root Account

You can switch to root account using the **sudo -i** (or **sudo su**) command. For security reasons, do not operate the **all** commands from the **root** account.

NOTE Click the following link for more information on the **sudo** command.
https://wiki.debian.org/sudo

ATTENTION

You might get the **permission denied** message when using pipe or redirect behavior with a non-root account.
You must use **‘sudo su –c’** to run the command instead of using >, <, >>, <<, etc.
Note: The single quotes enclosing the full command are required.

Creating and Deleting User Accounts

You can use the **useradd** and **userdel** commands to create and delete user accounts. Be sure to reference the main page of these commands to set relevant access privileges for the account. Following example shows how to create a **test1** user in the **sudo** group whose default login shell is **bash** and has home directory at **/home/test1**:

```
moxa@Moxa:~# sudo useradd -m -G sudo -s /bin/bash test1
```

To change the password for test1, use the **passwd** option along with the new password. Retype the password to confirm the change.

```
moxa@Moxa:~# sudo passwd test1
Enter new UNIX password:
Retype new UNIX password:
passwd: password updated successfully
```

To delete the user **test1**, use the **userdel** command.

```
moxa@Moxa:# sudo userdel test1
```

Disabling the Default User Account

ATTENTION

You should first create a user account before you disable the default account.

Use the **passwd** command to lock the default user account so that the **moxa** user cannot log in.

```
root@Moxa:# passwd -l moxa
```

To unlock the user moxa:

```
root@Moxa:# passwd -u moxa
```

Network Settings

Configuring Ethernet Interfaces

After the first login, you can configure the Arm-based computer's network settings to fit your application better. Note that it is more convenient to manipulate the network interface settings from the serial console than from an SSH login because an SSH connection can disconnect when there are network issues and the connection must be reestablished.

Modifying Network Settings via the Serial Console

In this section, we use the serial console to configure the Arm-based computer's network settings. Follow the instructions in the *Connecting to the Arm-based Computer* section under *Getting Started*, to access the Console Utility of the target computer via the serial Console port, and then type **`cd /etc/network`** to change directories.

```
moxa@Moxa:~$ cd /etc/network/
moxa@Moxa:/etc/network/~$
```

Type **`sudo vi interfaces`** to edit the network configuration file in the **vi** editor. You can configure the Arm-based computer's Ethernet ports to use either **static** or **dynamic** (DHCP) IP addresses.

Setting a Static IP address

To set a static IP address for the Arm-based computer, use the **`iface`** command to modify the default gateway, address, network, netmask, and broadcast parameters of the Ethernet interface.

```
# interfaces(5) file used by ifup(8) and ifdown(8)
auto eth0 eth1 lo
iface lo inet loopback

# embedded ethernet LAN1
#iface eth0 inet dhcp
iface eth0 inet static
       address 192.168.3.127
       network 192.168.3.0
       netmask 255.255.255.0
       broadcast 192.168.3.255

# embedded ethernet LAN2
iface eth1 inet static
       address 192.168.4.127
       network 192.168.4.0
       netmask 255.255.255.0
       broadcast 192.168.4.255~
```

Setting Dynamic IP Addresses

To configure one or both LAN ports to request an IP address dynamically use the **dhcp** option in place of the **static** in the **iface** command as follows:

Default Setting for LAN1	Dynamic Setting using DHCP
iface eth0 inet static address 192.168.3.127 network: 192.168.3.0 netmask 255.255.255.0 broadcast 192.168.3.255	iface eth0 inet dhcp

```
# embedded ethernet LAN1
iface eth0 inet dhcp
```

System Administration

Querying the Firmware Version

To check the Arm-based computer’s firmware version, type:

```
moxa@Moxa:~$ kversion
UC-2112-LX version 1.1
```

Add the **–a** option to create a full build version:

```
moxa@Moxa:~$ kversion -a
UC-2112-LX version 1.1 Build 18031118
```

Adjusting the Time

The Arm-based computer has two time settings. One is the system time, and the other is the RTC (Real Time Clock) time kept by the Arm-based computer’s hardware. Use the **date** command to query the current system time or set a new system time. Use the **hwclock** command to query the current RTC time or set a new RTC time.

Use the **date MMDDhhmmYYYY** command to set the system time:

MM = Month
DD = Date
hhmm = hour and minute

```
moxa@Moxa:~$ sudo date 071123192014
Mon Jul 11 23:19:00 UTC 2014
```

Use the following command to set the RTC time to system time:

```
moxa@Moxa:~$ sudo hwclock -w
moxa@Moxa:~$ sudo hwclock
2018-07-31 02:09:00.628145+0000
```

NOTE Click the following links for more information on date and time:
https://www.debian.org/doc/manuals/system-administrator/ch-sysadmin-time.html
https://wiki.debian.org/DateTime

Setting the Time Zone

There are two ways to configure the Moxa embedded computer’s time zone. One is using the **TZ** variable. The other is using the **/etc/localtime** file.

Using the TZ Variable

The format of the TZ environment variable looks like this:

TZ=*<Value>HH[:MM[:SS]][daylight[HH[:MM[:SS]]][,start date[/starttime], enddate[/endtime]]]*

Here are some possible settings for the North American Eastern time zone:

1. **TZ=EST5EDT**
2. **TZ=EST0EDT**
3. **TZ=EST0**

In the first case, the reference time is GMT and the stored time values are correct worldwide. A simple change of the TZ variable can print the local time correctly in any time zone.

In the second case, the reference time is Eastern Standard Time and the only conversion performed is for Daylight Saving Time. Therefore, there is no need to adjust the hardware clock for Daylight Saving Time twice per year.

In the third case, the reference time is always the time reported. You can use this option if the hardware clock on your machine automatically adjusts for Daylight Saving Time or you would like to manually adjust the hardware time twice a year.

```
moxa@Moxa:~$ TZ=EST5EDT
moxa@Moxa:~$ export TZ
```

You must include the TZ setting in the **/etc/rc.local** file. The time zone setting will be activated when you restart the computer.

The following table lists other possible values for the TZ environment variable:

Hours From Greenwich Mean Time (GMT)	Value	Description
0	GMT	Greenwich Mean Time
+1	ECT	European Central Time
+2	EET	European Eastern Time
+2	ART	
+3	EAT	Saudi Arabia
+3.5	MET	Iran
+4	NET	
+5	PLT	West Asia
+5.5	IST	India
+6	BST	Central Asia
+7	VST	Bangkok
+8	CTT	China
+9	JST	Japan
+9.5	ACT	Central Australia
+10	AET	Eastern Australia
+11	SST	Central Pacific
+12	NST	New Zealand
-11	MIT	Samoa
-10	HST	Hawaii
-9	AST	Alaska
-8	PST	Pacific Standard Time
-7	PNT	Arizona

Hours From Greenwich Mean Time (GMT)	Value	Description
-7	MST	Mountain Standard Time
-6	CST	Central Standard Time
-5	EST	Eastern Standard Time
-5	IET	Indiana East
-4	PRT	Atlantic Standard Time
-3.5	CNT	Newfoundland
-3	AGT	Eastern South America
-3	BET	Eastern South America
-1	CAT	Azores

Using the localtime File

The local time zone is stored in the **/etc/localtime** and is used by GNU Library for C (glibc) if no value has been set for the TZ environment variable. This file is either a copy of the **/usr/share/zoneinfo/** file or a symbolic link to it. The Arm-based computer does not provide **/usr/share/zoneinfo/** files. You should find a suitable time zone information file and write over the original local time file in the Arm-based computer.

Determining Available Drive Space

To determine the amount of available drive space, use the **df** command with the **–h** option. The system will return the amount of drive space broken down by file system. Here is an example:

```
moxa@Moxa:~$ df -h
Filesystem      Size  Used Avail Use% Mounted on
devtmpfs         803M  238M  524M  32% /
/dev/root       803M  238M  524M  32% /
tmpfs           25M  188K   25M   1% /run
tmpfs          5.0M     0  5.0M   0% /run/lock
tmpfs           10M     0   10M   0% /dev
tmpfs           50M     0   50M   0% /run/shm
```

Shutting Down the Device

To shut down the device, disconnect the power source to the computer. When the computer is powered off, main components such as the CPU, RAM, and storage devices are powered off, although an internal clock may retain battery power.

You can use the Linux command **shutdown** to close all software running on the device and halt the system. However, main components such as the CPU, RAM, and storage devices will continue to be powered after you run this command.

```
moxa@Moxa:~$ sudo shutdown -h now
```

3

Advanced Configuration of Peripherals

In this chapter, we include more information on the Arm-based computer's peripherals, such as the serial interface, storage, diagnostic LEDs, and the cellular module. The instructions in this chapter cover all functions supported in Moxa's Arm-based computers. Before referring to the sections in this chapter, make sure that they are applicable to and are supported by the hardware specification of your Arm-based computer.

The following topics are covered in this chapter:

Serial Ports

The serial ports support RS-232, RS-422, and RS-485 2-wire operation modes with flexible baudrate settings. The default operation mode is RS-232; use the **`mx-uart-ctl`** command to change the operation mode.

Usage:	mx-uart-ctl -p <#port_number> -m <#uart_mode>
Port number:	n = 0,1,2,...
uart mode:	As in the following table

Interface-no	Operation Mode
None	Display current setting
0	RS-232
1	RS-485 2-wire
2	RS-422 / RS-485 4-wire

For example, to set Port 0 to the RS-485 4-wire mode, use the following command:

```
root@Moxa:/home/moxa# mx-uart-ctl -p 0
Current uart mode is RS232 interface.
root@Moxa:/home/moxa# mx-uart-ctl -p 0 -m 2
Set OK.
Current uart mode is RS422/RS485-4W interface.
```

Changing the Serial Terminal Settings

The **`stty`** command is used to view and modify the serial terminal settings. The details are given below.

Displaying All Settings

Use the following command to display all serial terminal settings.

```
moxa@Moxa:~$ sudo stty -a -F /dev/ttyM0
speed 9600 baud; rows 0; columns 0; line = 0;
intr = ^C; quit = ^\; erase = ^?; kill = ^U; eof = ^D; eol = <undef>;
eol2 = <undef>; swtch = <undef>; start = ^Q; stop = ^S; susp = ^Z; rprnt = ^R;
werase = ^W; lnext = ^V; flush = ^O; min = 1; time = 0;
-parenb -parodd cs8 hupcl -cstopb cread clocal -crtscts
-ignbrk -brkint -ignpar -parmrk -inpck -istrip -inlcr -igncr icrnl ixon -ixoff
-iuclc -ixany -imaxbel -iutf8
opost -olcuc -ocrnl onlcr -onocr -onlret -ofill -ofdel nl0 cr0 tab0 bs0 vt0 ff0
isig icanon iexten echo echoe echok -echonl -noflsh -xcase -tostop -echoprt
echoctl echoke
```

Configuring Serial Settings

The following example changes the baudrate to 115200.

```
moxa@Moxa:~$ sudo stty 115200 -F /dev/ttyM0
```

Check the settings to confirm that the baudrate has changed to 115200.

```
moxa@Moxa:~$ sudo stty -a -F /dev/ttyM0
speed 115200 baud; rows 0; columns 0; line = 0;
intr = ^C; quit = ^\; erase = ^?; kill = ^U; eof = ^D; eol = <undef>;
eol2 = <undef>; swtch = <undef>; start = ^Q; stop = ^S; susp = ^Z; rprnt = ^R;
werase = ^W; lnext = ^V; flush = ^O; min = 1; time = 0;
-parenb -parodd cs8 hupcl -cstopb cread clocal -crtscts
-ignbrk -brkint -ignpar -parmrk -inpck -istrip -inlcr -igncr icrnl ixon -ixoff
-iuclc -ixany -imaxbel -iutf8
opost -olcuc -ocrnl onlcr -onocr -onlret -ofill -ofdel nl0 cr0 tab0 bs0 vt0 ff0
isig icanon iexten echo echoe echok -echonl -noflsh -xcase -tostop -echoprt
echoctl echoke
```

NOTE Detailed information on the **stty** utility is available at the following link:
http://www.gnu.org/software/coreutils/manual/coreutils.html

USB Port

The Arm-based computers are provided with a USB port for storage expansion.

USB Automount

The Arm-based computers support hot plug function for connecting USB mass storage devices. However, by default, the **automount** utility (udev) only supports auto-mounting of one partition. Use the **mount** command to view details about all partitions.

```
moxa@Moxa:~$ mount | grep media
```

ATTENTION

Remember to type the **sync** command before you disconnect the USB mass storage device to prevent loss of data.

Exit from the /media/* directory when you disconnect the storage device. If you stay in /media/usb*, the auto unmount process will fail. If that happens, type **#umount /media/usb*** to unmount the device manually.

CAN Bus Interface

The CAN ports on Moxa's Arm-based computers support CAN 2.0A/B standard.

Configuring the Socket CAN Interface

The CAN ports are initialized by default. If any additional configuration is needed, use the **`ip link`** command to check the CAN device.

To check the CAN device status, use the **`ip link`** command.

```
# ip link
can0: <NOARP,UP,LOWER_UP,ECHO> mtu 16 qdisc pfifo_fast state UNKNOWN mode DEFAULT
group default qlen 10 link/can
```

To configure the CAN device, use **# ip link set can0 down** to turn off the device first

```
# ip link set can0 down
# ip link
can0: <NOARP,ECHO> mtu 16 qdisc pfifo_fast state DOWN mode DEFAULT group default
qlen 10 link/can
```

Here's an example with bitrate 12500:

```
# ip link set can0 up type can bitrate 12500
```

CAN Bus Programming Guide

The following code is an example of the SocketCAN API, which sends packets using the raw interface.

CAN Write

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <string.h>
#include <net/if.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <sys/ioctl.h>
#include <linux/can.h>
#include <linux/can/raw.h>
int main(void)
{
    int s;
    int nbytes;
    struct sockaddr_can addr;
    struct can_frame frame;
    struct ifreq ifr;
    char *ifname = "can1";
    if((s = socket(PF_CAN, SOCK_RAW, CAN_RAW)) < 0) {
        perror("Error while opening socket");
        return -1;
    }
    strcpy(ifr.ifr_name, ifname);
    ioctl(s, SIOCGIFINDEX, &ifr);
    addr.can_family = AF_CAN;
    addr.can_ifindex = ifr.ifr_ifindex;
    printf("%s at index %d\n", ifname, ifr.ifr_ifindex);
    if(bind(s, (struct sockaddr *)&addr, sizeof(addr)) < 0) {
        perror("Error in socket bind");
        return -2;
    }
    frame.can_id = 0x123;
    frame.can_dlc = 2;
    frame.data[0] = 0x11;
    frame.data[1] = 0x22;
    nbytes = write(s, &frame, sizeof(struct can_frame));
    printf("Wrote %d bytes\n", nbytes);
    return 0;
}
```

CAN Read

The following sample code illustrates how to read the data.

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <string.h>
#include <net/if.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <sys/ioctl.h>
#include <linux/can.h>
#include <linux/can/raw.h>
Int main(void)
{
    int i;
    int s;
    int nbytes;
    struct sockaddr_can addr;
    struct can_frame frame;
    struct ifreq ifr;
    char *ifname = "can0";
    if((s = socket(PF_CAN, SOCK_RAW, CAN_RAW)) < 0) {
        perror("Error while opening socket");
        return -1;
    }
    strcpy(ifr.ifr_name, ifname);
    ioctl(s, SIOCGIFINDEX, &ifr);
    addr.can_family = AF_CAN;
    addr.can_ifindex = ifr.ifr_ifindex;
    printf("%s at index %d\n", ifname, ifr.ifr_ifindex);
    if(bind(s, (struct sockaddr *)&addr, sizeof(addr)) < 0) {
        perror("Error in socket bind");
        return -2;
    }
    nbytes = read(s, &frame, sizeof(struct can_frame));
    if (nbytes < 0) {
        perror("Error in can raw socket read");
        return 1;
    }
    if (nbytes < sizeof(struct can_frame)) {
        fprintf(stderr, "read: incomplete CAN frame\n");
        return 1;
    }
    printf(" %5s %03x [%d] ", ifname, frame.can_id, frame.can_dlc);
    for (i = 0; i < frame.can_dlc; i++)
        printf(" %02x", frame.data[i]);
    printf("\n");
    return 0;
}
```

After you use the SocketCAN API, the SocketCAN information is written to the paths: **/proc/sys/net/ipv4/conf/can*** and **/proc/sys/net/ipv4/neigh/can***

Configuring the Real COM Mode

IMPORTANT!

The UC-8100, UC-8100-ME-T, and UC-8100A-ME-T Series do not support Real COM mode.

You can use Moxa's NPort series serial device drivers to extend the number of serial interfaces (ports) on your Arm-based Moxa computer. The NPort comes equipped with COM drivers that work with Windows systems and TTY drivers for Linux systems. The driver establishes a transparent connection between the host and serial device by mapping the IP Port of the NPort's serial port to a local COM/TTY port on the host computer.

Real COM Mode also supports up to 4 simultaneous connections, so that multiple hosts can collect data from the same serial device at the same time.

One of the major conveniences of using Real COM Mode is that Real COM Mode allows users to continue using RS-232/422/485 serial communications software that was written for pure serial communications applications. The driver intercepts data sent to the host's COM port, packs it into a TCP/IP packet, and then redirects it through the host's Ethernet card. At the other end of the connection, the NPort accepts the Ethernet frame, unpacks the TCP/IP packet, and then sends it transparently to the appropriate serial device attached to one of the NPort's serial ports.

The Real COM driver is installed on the Arm-based computer by default. You will be able to view the driver related files in the **/usr/lib/npreal2/driver** folder.

```
> mxaddsvr (Add Server, mapping tty port) > mxdelsvr (Delete Server,
unmapping tty port)
> mxloadsvr (Reload Server) > mxmknod (Create device node/tty port)
> mxrmnod (Remove device node/tty port)
> mxuninst (Remove tty port and driver files)
```

At this point, you will be ready to map the NPort serial port to the system **tty** port. For a list of supported NPort devices and their revision history, click https://www.moxa.com/en/support/search?psid=50278.

Mapping TTY Ports

Make sure that you set the operation mode of the desired NPort serial port to Real COM mode. After logging in as a super user, enter the directory /usr/lib/npreal2/driver and then execute mxaddsvr to map the target NPort serial port to the host tty ports. The syntax of **`mxaddsvr`** command is as follows:

```
mxaddsvr [NPort IP Address] [Total Ports] ([Data port] [Cmd port])
```

The **`mxaddsvr`** command performs the following actions:

1. Modifies the npreal2d.cf.
2. Creates tty ports in the /dev directory with major & minor number configured in npreal2d.cf.
3. Restarts the driver.

Mapping TTY Ports (automatic)

To map tty ports automatically, execute the **`mxaddsvr`** command with just the IP address and the number of ports, as shown in the following example:

```
# cd /usr/lib/npreal2/driver
# ./mxaddsvr 192.168.3.4 16
```

In this example, 16 tty ports will be added, all with IP 192.168.3.4 consisting of data ports from 950 to 965 and command ports from 966 to 981.

Mapping TTY Ports (manual)

To map tty ports manually, execute the **`mxaddsvr`** command and specify the data and command ports as shown in the following example:

```
# cd /usr/lib/npreal2/driver
# ./mxaddsvr 192.168.3.4 16 4001 966
```

In this example, 16 tty ports will be added, all with IP 192.168.3.4, with data ports from 4001 to 4016 and command ports from 966 to 981.

Removing Mapped TTY Ports

After logging in as root, enter the directory /usr/lib/npreal2/driver and then execute the **`mxdelsvr`** command to delete a server. The syntax of **`mxdelsvr`** is:

```
mxdelsvr [IP Address]
```

Example:

```
# cd /usr/lib/npreal2/driver
# ./mxdelsvr 192.168.3.4
```

The following actions are performed when the **`mxdelsvr`** command is executed:

1. Modify npreal2d.cf.
2. Remove the relevant tty ports from the /dev directory.
3. Restart the driver.

If the IP address is not provided in the command line, the program will list the installed servers and total ports on the screen. You will need to choose a server from the list for deletion.

4

Configuring of Wireless Connectivity

The instructions in this chapter cover all wireless functions supported in Moxa's Arm-based computers. Before referring to the sections in this chapter, make sure that they are applicable to and are supported by the hardware specification of your Arm-based computer platform.

The following topics are covered in this chapter:

Configuring the Cellular Connection

Using Cell_mgmt

The cell_mgmt utility is used to manage the cellular module in the computer. To run the **`cell_mgmt`** command, you must use **`sudo`** or run the command with root permission. The utility does not support SMS and MMS communication.

Manual Page

```
NAME
   cell_mgmt

USAGE
   cell_mgmt [-i <module id>] [options]

OPTIONS
      -i <module id>
             Module identifier, start from 0 and default to 0.
      -s <slot id>
             Slot identifier, start from 1 and default value depends
             on module interface.
             example: module 0 may in slot 2
      modules
             Shows module numbers supported.
      slot
             Shows module slot id
      interface [interface id]
             Switching and checking module interface(s)
      start [OPTIONS]
             Start network.

             OPTIONS:
             PIN - PIN code
             Phone - Phone number (especially for AT based modules)
             Auth - Authentication type(CHAP|PAP|BOTH), default=NONE.
             Username
             Password

             example:
                cell_mgmt start
                cell_mgmt start PIN=0000
                cell_mgmt start PIN=0000 Phone=*99#
                cell_mgmt start PIN=0000 Phone=*99# \
                      Auth=BOTH Username=moxa Password=moxamoxa
      stop
             network.
      power_on
             Power ON.
      power_off
             Power OFF.
      power_cycle
             Power cycle the module slot.
```

```
    switch_sim <1|2>
            Switch SIM slot.
    gps_on
            GPS ON.
    gps_off
            GPS OFF.
    attach_status
            Query network registration status.
    status
            Query network connection status.
    signal
            Get signal strength.
    at <'AT_COMMAND'>
            Input AT Command.
            Must use SINGLE QUOTATION to enclose AT Command.
    sim_status
            Query sim card status.
    unlock_pin <PIN>
            Unlock PIN code and save to configuration file.
    pin_retries
            Get PIN code retry remain times.
    pin_protection <enable|disable> <current PIN>
            Set PIN protection in the UIM.
    set_flight_mode <0|1>
            Set module into flight mode (1) or online mode (0).
    set_apn <APN>
            Set APN to configuration file.
    check_carrier
            Check current carrier.
    switch_carrier <Verizon|ATT|Sprint|Generic>
            Switching between US carrier frequency bands.
    m_info
            Module/SIM information.
    module_info
            Module information.
    module_ids
            Get device IDs (ex: IMEI and/or ESN).
    iccid
            Get SIM card ID
    imsi
            Get IMSI (International Mobile Subscriber Identity).
    location_info
            Get cell location information.
    operator
            Telecommunication operator.
    vzwauto
            Verizon Private Network auto dialup.
    version
            Cellular management version.
```

Dial-up Process

Before dialing, ensure that the APN (Access Point Name) is set correctly and the cellular module has attach with the base station.

1. Unlock the PIN code (if the SIM is locked using a PIN code).
   Use the **`cell_mgmt sim_status`** command to check the SIM card status and the **`cell_mgmt unlock_pin`** *<PIN>* command to unlock the SIM card if a SIM PIN is set.

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt sim_status
+CPIN: READY
```

2. Use the **`cell_mgmt set_apn`** *<APN>* command to set the name of the access point that will be used to connect to the carrier.

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt set_apn internet
old APN=test, new APN=internet
```

3. Check if the service attaches with the correct APN.

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt attach_status
CS: attached
PS: attached
```

   PS (packet-switched) should be **attached** to establish a network connection.

4. Dial up using the **`cell_mgmt start`** command.

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt start
PIN code: Disabled or verified
Starting network with '_qmicli --wds-start-network=apn=internet,ip-type=4 --
client-no-release-cid --device-open-net=net-802-3|net-no-qos-header'...
Saving state... (CID: 8)
Saving state... (PDH: 1205935456)
Network started successfully
```

   The dial-up function in the **`cell_mgmt`** utility will automatically set the DNS and default gateway of the computer, if they have not been set.

Dial-up Commands

cell_mgmt start

To start a network connection, use the default cellular module of the computer (If the computer supports multiple modules, use the **`cell_mgmt interface`** command to verify the default module that is selected).

If you run the **`cell_mgmt start`** command with the Username, Password, and PIN, all the configurations will be written into the configuration file **`/etc/moxa-cellular-utils/moxa-cellular-utils.conf`**.

This information is then used when you run the command without specifying the options.

Usage: **`cell_mgmt start Username=[user] Password=[pass] PIN=[pin_code]`**

cell_mgmt stop

Stops/disables the network connection on the cellular module of the computer

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt stop
Killed old client process
Stopping network with '_qmicli --wds-stop-network=1205933264 --client-cid=8'...
Network stopped successfully
Clearing state...
```

cell_mgmt status

Provides information on the status of the network connection.

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt status
Status: connected
```

cell_mgmt signal

Provides the cellular signal strength.

For moxa-cellular-utils version 2.0.0 and later, cellular signal strength is indicated using levels.

```
root@Moxa:/home/moxa$ sudo cell_mgmt signal
4G Level 4 (Good)
```

Level	Description
5	Excellent
4	Good
3	Fair
2	Poor
1	Very Poor
0	No Signal

For moxa-cellular-utils versions prior to version 2.0.0, the cellular signal strength is measured using Reference Signal Received Power (RSRP). The following table lists the signal strength for RSRP ranges.

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt signal
umts -77 dbm
```

RSRP	Signal Strength
<-115 dBm	No signal
-105 to -115 dBm	Poor
-95 to -105 dBm	Fair
-85 to -95 dBm	Good
>-85 dBm	Excellent

cell_mgmt operator

Provides information on the cellular service provider.

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt operator
Chunghwa
```

Cellular Module

cell_mgmt module_info

Provides information of the cellular module (AT port, GPS port, QMI port, and module name, etc.).

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt module_info
SLOT: 1
Module: MC7354
WWAN_node: wwan0
AT_port: /dev/ttyUSB2
GPS_port: /dev/ttyUSB1
QMI_port: /dev/cdc-wdm0
Modem_port: NotSupport
```

cell_mgmt interface [id]

Used to view the supported modules and default module on the computer with their IDs. Change the default module by specifying the ID.

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt interface
[0] wwan0    <Current>
```

cell_mgmt power_cycle

Use the **cell_mgmt power_cycle** command to power cycle the cellular module in the computer. You may see a kernel message that the module has been reloaded.

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt power_cycle
Network already stopped
Clearing state...
[232733.202208] usb 1-1: USB disconnect, device number 2
[232733.217132] qcserial ttyUSB0: Qualcomm USB modem converter now disconnected
from ttyUSB0
[232733.225616] qcserial 1-1:1.0: device disconnected
[232733.256738] qcserial ttyUSB1: Qualcomm USB modem converter now disconnected
from ttyUSB1
[232733.265214] qcserial 1-1:1.2: device disconnected
[232733.281566] qcserial ttyUSB2: Qualcomm USB modem converter now disconnected
from ttyUSB2
[232733.290006] qcserial 1-1:1.3: device disconnected
[232733.313572] qmi_wwan 1-1:1.8 wwan0: unregister 'qmi_wwan' usb-musb-
hdrc.0.auto-1, WWAN/QMI device
[232746.879873] usb 1-1: new high-speed USB device number 3 using musb-hdrc
[232747.020358] usb 1-1: config 1 has an invalid interface number: 8 but max is 3
[232747.027639] usb 1-1: config 1 has no interface number 1
[232747.036212] usb 1-1: New USB device found, idVendor=1199, idProduct=68c0
[232747.043185] usb 1-1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[232747.050473] usb 1-1: Product: MC7354
[232747.054151] usb 1-1: Manufacturer: Sierra Wireless, Incorporated
[232747.068022] qcserial 1-1:1.0: Qualcomm USB modem converter detected
[232747.079525] usb 1-1: Qualcomm USB modem converter now attached to ttyUSB0
[232747.089754] qcserial 1-1:1.2: Qualcomm USB modem converter detected
[232747.099156] usb 1-1: Qualcomm USB modem converter now attached to ttyUSB1
```

```
[232747.109317] qcserial 1-1:1.3: Qualcomm USB modem converter detected
[232747.118581] usb 1-1: Qualcomm USB modem converter now attached to ttyUSB2
[232747.130890] qmi_wwan 1-1:1.8: cdc-wdm0: USB WDM device
[232747.137174] qmi_wwan 1-1:1.8 wwan0: register 'qmi_wwan' at usb-musb-
hdrc.0.auto-1, WWAN/QMI device, 0a:ba:e1:d6:ed:4a
```

cell_mgmt check_carrier

The **`cell_mgmt check_carrier`** command helps to check if the current carrier matches with the service (SIM card) provider.

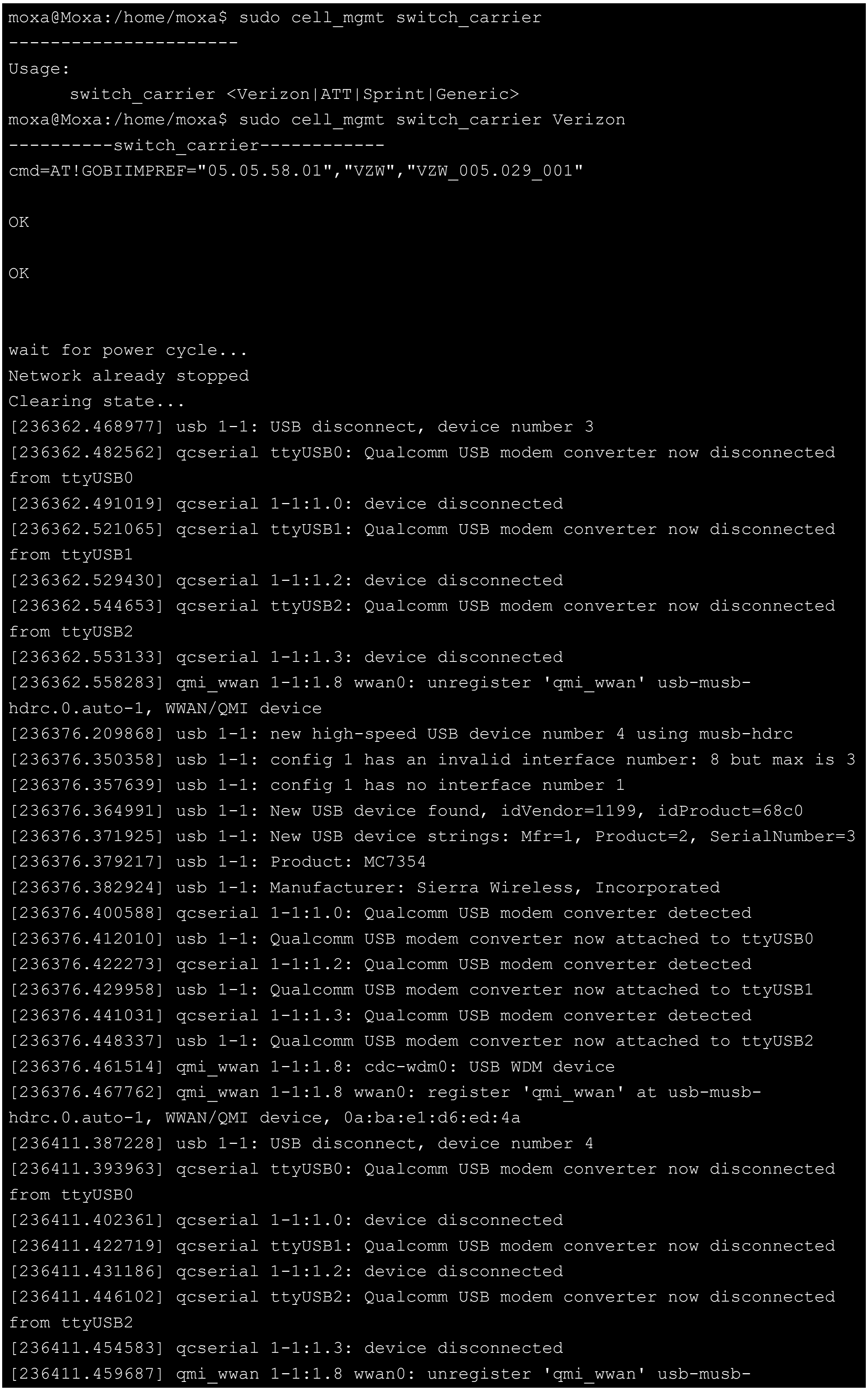
```
moxa@Moxa:/home/moxa$ sudo cell_mgmt check_carrier
----------Carrier Info----------
preferred firmware=05.05.58.01
preferred carrier name=ATT
preferred carrier config=ATT_005.026_000
firmware=05.05.58.01
carrier name=ATT
carrier config=ATT_005.026_000
--------------------------------
```

cell_mgmt switch_carrier

Some modules provide multiple carrier support. Use the **`cell_mgmt switch_carrier`** command to switch between carriers. It may take some time (depending on the module's mechanism) to switch between carriers.

For the UC-2114 and UC-2116 computers, refer to the following table for a list of the cellular carriers supported.

MNO Profile (UC-2114 & UC-2116)	**System Selection (Primary/Secondary)**	**LTE Bands Supported**	**UBANDMASK Support**
Default	M1/NB1	2, 3, 4, 5, 8, 12, 13, 18, 19, 20, and 25 (M1 only)	No
AT&T	M1 only	2, 4, 5, and 12	No
China Telecom	M1/NB1	3, 5, and 8	Yes
Deutsche Telekom	M1/NB1	3, 8, and 20	Yes
Sprint	M1 only	2, 4, 12, and 25	Yes
Standard Europe	M1/NB1	3, 8, and 20	Yes
Telstra	M1 only	3, 5, 8, and 28	No
T-Mobile USA	NB1 only	2, 4, 5, and 12	Yes
TELUS	M1 only	2, 4, 5, and 12	No
Verizon	M1 only	13	No
Vodafone	NB1/M1	3, 8, and 20	Yes



```
moxa@Moxa:/home/moxa$ sudo cell_mgmt switch_carrier
----------------------
Usage:
      switch_carrier <Verizon|ATT|Sprint|Generic>
moxa@Moxa:/home/moxa$ sudo cell_mgmt switch_carrier Verizon
----------switch_carrier------------
cmd=AT!GOBIIMPREF="05.05.58.01","VZW","VZW_005.029_001"

OK

OK


wait for power cycle...
Network already stopped
Clearing state...
[236362.468977] usb 1-1: USB disconnect, device number 3
[236362.482562] qcserial ttyUSB0: Qualcomm USB modem converter now disconnected
from ttyUSB0
[236362.491019] qcserial 1-1:1.0: device disconnected
[236362.521065] qcserial ttyUSB1: Qualcomm USB modem converter now disconnected
from ttyUSB1
[236362.529430] qcserial 1-1:1.2: device disconnected
[236362.544653] qcserial ttyUSB2: Qualcomm USB modem converter now disconnected
from ttyUSB2
[236362.553133] qcserial 1-1:1.3: device disconnected
[236362.558283] qmi_wwan 1-1:1.8 wwan0: unregister 'qmi_wwan' usb-musb-
hdrc.0.auto-1, WWAN/QMI device
[236376.209868] usb 1-1: new high-speed USB device number 4 using musb-hdrc
[236376.350358] usb 1-1: config 1 has an invalid interface number: 8 but max is 3
[236376.357639] usb 1-1: config 1 has no interface number 1
[236376.364991] usb 1-1: New USB device found, idVendor=1199, idProduct=68c0
[236376.371925] usb 1-1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[236376.379217] usb 1-1: Product: MC7354
[236376.382924] usb 1-1: Manufacturer: Sierra Wireless, Incorporated
[236376.400588] qcserial 1-1:1.0: Qualcomm USB modem converter detected
[236376.412010] usb 1-1: Qualcomm USB modem converter now attached to ttyUSB0
[236376.422273] qcserial 1-1:1.2: Qualcomm USB modem converter detected
[236376.429958] usb 1-1: Qualcomm USB modem converter now attached to ttyUSB1
[236376.441031] qcserial 1-1:1.3: Qualcomm USB modem converter detected
[236376.448337] usb 1-1: Qualcomm USB modem converter now attached to ttyUSB2
[236376.461514] qmi_wwan 1-1:1.8: cdc-wdm0: USB WDM device
[236376.467762] qmi_wwan 1-1:1.8 wwan0: register 'qmi_wwan' at usb-musb-
hdrc.0.auto-1, WWAN/QMI device, 0a:ba:e1:d6:ed:4a
[236411.387228] usb 1-1: USB disconnect, device number 4
[236411.393963] qcserial ttyUSB0: Qualcomm USB modem converter now disconnected
from ttyUSB0
[236411.402361] qcserial 1-1:1.0: device disconnected
[236411.422719] qcserial ttyUSB1: Qualcomm USB modem converter now disconnected
[236411.431186] qcserial 1-1:1.2: device disconnected
[236411.446102] qcserial ttyUSB2: Qualcomm USB modem converter now disconnected
from ttyUSB2
[236411.454583] qcserial 1-1:1.3: device disconnected
[236411.459687] qmi_wwan 1-1:1.8 wwan0: unregister 'qmi_wwan' usb-musb-
```

```
hdrc.0.auto-1, WWAN/QMI device
[236423.109879] usb 1-1: new high-speed USB device number 5 using musb-hdrc
[236423.250364] usb 1-1: config 1 has an invalid interface number: 8 but max is 3
[236423.257649] usb 1-1: config 1 has no interface number 1
[236423.266064] usb 1-1: New USB device found, idVendor=1199, idProduct=68c0
[236423.273024] usb 1-1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[236423.280331] usb 1-1: Product: MC7354
[236423.284011] usb 1-1: Manufacturer: Sierra Wireless, Incorporated
[236423.298320] qcserial 1-1:1.0: Qualcomm USB modem converter detected
[236423.310356] usb 1-1: Qualcomm USB modem converter now attached to ttyUSB0
[236423.318614] qcserial 1-1:1.2: Qualcomm USB modem converter detected
[236423.328841] usb 1-1: Qualcomm USB modem converter now attached to ttyUSB1
[236423.338942] qcserial 1-1:1.3: Qualcomm USB modem converter detected
[236423.348418] usb 1-1: Qualcomm USB modem converter now attached to ttyUSB2
[236423.360733] qmi_wwan 1-1:1.8: cdc-wdm0: USB WDM device
[236423.366960] qmi_wwan 1-1:1.8 wwan0: register 'qmi_wwan' at usb-musb-
hdrc.0.auto-1, WWAN/QMI device, 0a:ba:e1:d6:ed:4a
moxa@Moxa:/home/moxa$ sudo cell_mgmt check_carrier
----------Carrier Info----------
preferred firmware=05.05.58.01
preferred carrier name=VZW
preferred carrier config=VZW_005.029_001
firmware=05.05.58.01
carrier name=VZW
carrier config=VZW_005.029_001
--------------------------------
```

cell_mgmt at *AT_COMMAND*

Used to input an AT command. For example, use the AT command, **AT+CSQ** as follows:

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt at 'AT+CSQ'

+CSQ: 18,99

OK
```

Configuring a NB-IoT/Cat. M1 Connection (UC-2114 and UC-2116 only)

You can change the RAT (radio access technology) type of the NB-IoT module in UC-2114 and UC-2116 using the following AT commands:

Switching to the Cat. M1 Mode

```
moxa@Moxa:/home/moxa$ cell_mgmt at 'AT+COPS=2'
moxa@Moxa:/home/moxa$ cell_mgmt at 'AT+URAT=7'
moxa@Moxa:/home/moxa$ cell_mgmt at 'AT+COPS=0'
```

Switching to the NB-IoT Mode

```
moxa@Moxa:/home/moxa$ cell_mgmt at 'AT+COPS=2'
moxa@Moxa:/home/moxa$ cell_mgmt at 'AT+URAT=8'
moxa@Moxa:/home/moxa$ cell_mgmt at 'AT+COPS=0'
```

NOTE

- The APN name 'internet.iot' is set by the user. For information on the APN settings, contact your mobile network operator.
- A PPP dial-up connection that uses Cat. M1 and CAT. NB1 may sometimes take a couple of minutes to establish a connection if the signal is weak.
- Power saving mode (PSM) is not supported in the UC-2114 and UC-2116 computers.

You can also use an AT command to read the mode:

```
cell_mgmt at AT+URAT?

root@Moxa:/home/moxa# cell_mgmt at AT+URAT?

+URAT: 7,8

OK

7: CAT-M1
8: NB-IOT
```

GPS

UC-8112-ME-T-US-LTE Model

To view the GPS information for the UC-8112-ME-T-US-LTE model, do the following:

1. Power on the GPS module using the command:

```
root@Moxa:/home/moxa# cell_mgmt gps_on
```

2. Check the GPS port using the **`cell_mgmt`** command.
   In the following example, the GPS port is at **/dev/ttyUSB1**.

```
root@Moxa:/home/moxa# cell_mgmt module_info
SLOT: 1
Module: MC7354
WWAN_node: wwan1
AT_port: /dev/ttyUSB2
GPS_port: /dev/ttyUSB1
QMI_port: /dev/cdc-wdm1
Modem_port: NotSupport
AT_port (reserved): NotSupport
```

3. Type the following command to get the GPS location information from the GPS port.

```
root@Moxa:/home/moxa# cat /dev/ttyUSB1
```

For Other Models

Use **cell_mgmt module_info** to get information of the cellular module including the GPS port information.

```
moxa@Moxa:/home/moxa$ sudo cell_mgmt module_info
SLOT: 1
Module: MC7354
WWAN_node: wwan0
AT_port: /dev/ttyUSB2
GPS_port: /dev/ttyUSB1
QMI_port: /dev/cdc-wdm0
Modem_port: NotSupport
```

Type the following command to get the GPS location information from the GPS port.

```
root@Moxa:/home/moxa# cat /dev/ttyUSB1
```

Configuring the Wi-Fi Connection

You can configure the Wi-Fi connection for your Arm-based computer using a configuration file or the **wifi_mgmt** utility provided by Moxa. For advanced settings, you can use the **`wpa_supplicant`** command.

Configuring WPA2

Moxa's Arm-based computers support WPA2 security using the **/sbin/wpa_supplicant** program. Refer to the following table for the configuration options. The **Key required before joining network?** column specifies whether an encryption and/or authentication key must be configured before associating with a network.

Infrastructure mode	Authentication mode	Encryption status	Manual Key required?	IEEE 802.1X enabled?	Key required before joining network?
ESS	Open	None	No	No	No
ESS	Open	WEP	Optional	Optional	Yes
ESS	Shared	None	Yes	No	Yes
ESS	Shared	WEP	Optional	Optional	Yes
ESS	WPA	WEP	No	Yes	No
ESS	WPA	TKIP	No	Yes	No
ESS	WPA2	AES	No	Yes	No
ESS	WPA-PSK	WEP	Yes	Yes	No
ESS	WPA-PSK	TKIP	Yes	Yes	No
ESS	WPA2-PSK	AES	Yes	Yes	No

Using wifi_mgmt

Manual Page

The **wifi_mgmt** utility manages the behavior of the Wi-Fi module.

```
moxa@Moxa:~$ sudo wifi_mgmt help
[sudo] password for moxa:
Usage:
/usr/sbin/wifi_mgmt [-i <interface id>] [-s <slot id>] [OPTIONS]
OPTIONS
start Type=[type] SSID=[ssid] Password=[password]
```

```
Insert an AP information to the managed AP list and then connect to the AP.
[type] open/wep/wpa/wpa2
[ssid] access point's SSID
[password] access point's password
example:
wifi_mgmt start Type=wpa SSID=moxa_ap Password=moxa
wifi_mgmt start Type=open SSID=moxa_ap
start [num]
Connect to AP by the managed AP list number.
start
Connect to the last time AP that was used.
scan -d
Scan all the access points information and show the detail message.
scan
Scan all the access points information.
signal
Show the AP's signal.
list
Show the managed AP list.
insert Type=[type] SSID=[ssid] Password=[password]
Insert a new AP information to the managed AP list.
[type] open/wep/wpa/wpa2
[ssid] access point's SSID
[password] access point's password
example:
wifi_mgmt insert Type=wpa SSID=moxa_ap Password=moxa
select [num]
Select an AP num to connect which is in the managed AP list.
stop
Stop network.
status
Query network connection status.
interface [num]
Switch to another wlan[num] interface.
[num] interface number
example:
wifi_mgmt interface 0
interface
Get the current setting interface.
reconnect
Reconnect to the access point.
restart
Stop wpa_supplicant then start it again.
version
Wifi management version.
```

Connecting to an AP

You can connect your computer to an AP using the following three commands. The DNS and default gateway will be configured automatically. If you want to use the wireless interface's gateway, you must clean up your computer's default gateway configuration.

wifi_mgmt start Type=*[type]* SSID=*[ssid]* Password=*[password]*

Insert the AP information in the managed AP list and then connect to the AP.

```
root@Moxa:~# wifi_mgmt start Type=wpa SSID=moxa_ap Password=moxa
wpa_state=COMPLETED
*** Get DHCP IP address from AP ***
*** Get DHCP IP from AP! ***
```

wifi_mgmt start *[num]*

Connect to the AP using the managed AP list number. If you have inserted the AP information before, the information may still be in the managed AP list. Check the managed AP list using the **`wifi_mgmt list`** command.

```
root@Moxa:~# wifi_mgmt list
network id / ssid / bssid / flags
0 MOXA_AP1 any [LAST USED]
1 MOXA_AP2 any [DISABLED]
2 MOXA_AP3 any [DISABLED]
```

Choose an AP number to start.

```
root@Moxa:~# wifi_mgmt start 1
wpa_state=COMPLETED
*** Get DHCP IP address from AP ***
*** Get DHCP IP from AP! ***
```

wifi_mgmt start

Connect to the previous AP that was used.

```
root@Moxa:~# wifi_mgmt list
network id / ssid / bssid / flags
0 MOXA_AP1 any [LAST USED]
1 MOXA_AP2 any [DISABLED]
2 MOXA_AP3 any [DISABLED]
```

Use the **`wifi_mgmt`** command to connect to the AP "MOXA_AP1" that was used the previous time as follows:

```
root@Moxa:~# wifi_mgmt start
wpa_state=COMPLETED
*** Get DHCP IP address from AP ***
*** Get DHCP IP from AP! ***
```

Stop or Restart a Network Connection

wifi_mgmt stop

```
root@Moxa:~# wifi_mgmt stop
Stopped.
```

wifi_mgmt restart

```
root@Moxa:~# wifi_mgmt restart
wpa_supplicant is closed!!
wpa_state=COMPLETED
*** Get DHCP IP address from AP ***
*** Get DHCP IP from AP! ***
```

Inserting an AP or Choosing Another AP to Connect To

If you want to insert and AP use the **`wifi_mgmt insert`** command.

```
root@Moxa:~# wifi_mgmt insert Type=wpa2 SSID=MOXA_AP3 Password=moxa
root@Moxa:~# wifi_mgmt list
network id / ssid / bssid / flags
0 MOXA_AP1 any [CURRENT]
1 MOXA_AP2 any [DISABLED]
2 MOXA_AP3 any [DISABLED]
```

If you want to use another AP to connect, use the **`wifi_mgmt select`** command to switch to the AP.

```
root@Moxa:~# wifi_mgmt list
network id / ssid / bssid / flags
0 MOXA_AP1 any [DISABLED]
1 MOXA_AP2 any [CURRENT]
2 MOXA_AP3 any [DISABLED]
root@Moxa:~# wifi_mgmt select 2
wpa_state=COMPLETED
*** Get DHCP IP address from AP ***
*** Get DHCP IP from AP! ***
```

Other Functions

wifi_mgmt scan

Scan all of the access point information.

```
root@Moxa:~# wifi_mgmt scan
bssid / frequency / signal level / flags / ssid
b0:b2:dc:dd:c9:e4 2462 -57 [WPA-PSK-TKIP][ESS] WES_AP
fc:f5:28:cb:8c:23 2412 -57 [WPA2-EAP-CCMP-preauth][ESS] MHQ-NB
fe:f0:28:cb:8c:23 2412 -59 [WPA2-EAP-CCMP-preauth][ESS] MHQ-Mobile
fc:f5:28:cb:39:08 2437 -79 [WPA2-EAP-CCMP-preauth][ESS] MHQ-NB
fe:f0:28:cb:39:08 2437 -81 [WPA2-EAP-CCMP-preauth][ESS] MHQ-Mobile
fc:f5:28:cb:5d:a8 2462 -83 [WPA2-EAP-CCMP-preauth][ESS] MHQ-NB
2c:54:cf:fd:5a:cf 2437 -83 [WPA-PSK-TKIP][ESS] 5566fans
fe:f0:28:cb:5d:a8 2462 -87 [WPA2-EAP-CCMP-preauth][ESS] MHQ-Mobile
fe:f0:28:cb:5d:78 2462 -89 [WPA2-EAP-CCMP-preauth][ESS] MHQ-Mobile
fe:f0:28:cb:39:11 2437 -89 [WPA2-EAP-CCMP-preauth][ESS] MHQ-Mobile
fc:f5:28:cb:39:11 2437 -91 [WPA2-EAP-CCMP-preauth][ESS] MHQ-NB
fe:f0:28:cb:39:0b 2412 -91 [WPA2-EAP-CCMP-preauth][ESS] MHQ-Mobile
02:1a:11:f1:dc:a1 2462 -91 [WPA2-PSK-CCMP][ESS] M9 Davidoff
fc:f5:28:cb:5d:78 2462 -93 [WPA2-EAP-CCMP-preauth][ESS] MHQ-NB
fe:f0:28:cb:5d:b7 2462 -93 [WPA2-EAP-CCMP-preauth][ESS] MHQ-Mobile
fc:f5:28:cb:39:0b 2412 -93 [WPA2-EAP-CCMP-preauth][ESS] MHQ-NB
fc:f5:28:cb:5d:b7 2462 -95 [WPA2-EAP-CCMP-preauth][ESS] MHQ-NB
fc:f5:28:cb:5d:93 2462 -97 [WPA2-EAP-CCMP-preauth][ESS] MHQ-NB
```

wifi_mgmt scan -d

Scan all of the access point information and show a detailed message.

```
root@Moxa:~# wifi_mgmt scan -d
wlan0 Scan completed :
Cell 01 - Address: FC:F5:28:CB:8C:23
Channel:1
Frequency:2.412 GHz (Channel 1)
Quality=51/70 Signal level=-59 dBm
Encryption key:on
ESSID:"MHQ-NB"
9 Mb/s; 12 Mb/s; 18 Mb/s
Mode:Master
Group Cipher : CCMP
Pairwise Ciphers (1) : CCMP
Authentication Suites (1) : 802.1x
Preauthentication Supported
Cell 02 - Address: FE:F0:28:CB:5D:A8
Channel:11
Frequency:2.462 GHz (Channel 11)
Quality=25/70 Signal level=-85 dBm
Encryption key:on
ESSID:"MHQ-Mobile"
9 Mb/s; 12 Mb/s; 18 Mb/s
Mode:Master
Group Cipher : CCMP
Pairwise Ciphers (1) : CCMP
Authentication Suites (1) : 802.1x
Preauthentication Supported
More.. .. ..
```

wifi_mgmt signal

Show the AP's signal.

```
root@Moxa:~# wifi_mgmt signal
level=-59 dBm
```

wifi_mgmt delete

```
root@Moxa:~# wifi_mgmt list
network id / ssid / bssid / flags
0 MOXA_AP1 any [CURRENT]
1 MOXA_AP1 any [DISABLED]
2 MOXA_AP3 any [DISABLED]
root@Moxa:~# wifi_mgmt delete 2
***** WARNING *****
Are you sure that you want to delete network id 2 (y/n)y
network id / ssid / bssid / flags
0 MOXA_AP1 any
1 MOXA_AP2 any [DISABLED]
```

wifi_mgmt status

```
root@Moxa:~# wifi_mgmt status
bssid=b0:b2:dc:dd:c9:e4
ssid=MOXA_AP1
id=0
mode=station
pairwise_cipher=TKIP
```

```
group_cipher=TKIP
key_mgmt=WPA-PSK
wpa_state=COMPLETED
ip_address=192.168.1.36
address=00:0e:8e:4c:13:5e
```

wifi_mgmt interface [num]

If there is more than one Wi-Fi interface, you can change the interface.

```
root@Moxa:~# wifi_mgmt interface
There is(are) 2 interface(s):
wlan0 [Current]
wlan1
root@Moxa:~# wifi_mgmt interface 1
Now is setting the interface as wlan1.
```

wifi_mgmt reconnect

```
root@Moxa:~# wifi_mgmt reconnect
wpa_state=SCANNING
wpa_state=SCANNING
wpa_state=COMPLETED
*** Get DHCP IP address from AP ***
*** Get DHCP IP from AP! ***
```

wifi_mgmt version

```
root@Moxa:~# wifi_mgmt version
wifi_mgmt version 1.0 Build 15050223
```

Configuring the Wireless LAN Using the Configuration File

You can edit the **/etc/wpa_supplicant/wpa_supplicant.conf** file to configure a Wi-Fi connection. The following is an example of the configuration file for an OPEN/WEP/WPA/WPA2 access point.

```
ctrl_interface=/var/run/wpa_supplicant
ctrl_interface_group=wheel
update_config=1
### Open system ###
#network={
# ssid="Open"
# key_mgmt=NONE
#}
###################
##### WEP #####
#network={
# ssid="WEP-ssid"
# bssid=XX:XX:XX:XX:XX:XX
# key_mgmt=NONE
# wep_key0=KEY
#}
###############
##### WPA/WPA2 PSK #####
#network={
# ssid="WPA-ssid"
# proto=WPA WPA2 RSN
# key_mgmt=WPA-PSK
# pairwise=TKIP CCMP
# group=TKIP CCMP
# psk="KEY"
#}
#######################
```

The basic command to connect to a WPA-supplicant is:

```
root@Moxa:~# wpa_supplicant -i <interface> -c <configuration file> -B
```

The **-B** option should be included because it forces the supplicant to run in the background.

1. Connect with the following command after editing the **wpa_supplicant.conf** file:

   ```
   root@Moxa:~# wpa_supplicant -i wlan0 -c
   /etc/wpa_supplicant/wpa_supplicant.conf -B
   ```

2. Use the **#sudo apt-get install wireless-tools** command to install the Wi-Fi utility.

   You can use the **iwconfig** command to check the connection status. The response you receive should be similar to the following:

   ```
   wlan0 IEEE 802.11abgn ESSID:"MOXA_AP"
   Mode:Managed Frequency:2.462 GHz Access Point: 00:1F:1F:8C:0F:64
   Bit Rate=36 Mb/s Tx-Power=27 dBm
   Retry min limit:7 RTS thr:off Fragment thr:off
   Encryption key:1234-5678-90 Security mode:open
   Power Management:off
   Link Quality=37/70 Signal level=-73 dBm
   Rx invalid nwid:0 Rx invalid crypt:0 Rx invalid frag:0
   Tx excessive retries:0 Invalid misc:0 Missed beacon:0
   ```

WARNING

Moxa strongly advises against using the WEP and WPA encryption standards. Both are now officially deprecated by the Wi-Fi Alliance, and are considered insecure. To guarantee good Wi-Fi encryption and security, use WPA2 with the AES encryption algorithm.

Configuring the Bluetooth Connection

Bluetooth connectivity is supported in the following computer models.

Computer Model	Bluetooth Version	Accessory Required
UC-3111-T-US-LX v.2.0.0	4.2	None. Bluetooth module is built-in
UC-3121-T-US-LX v.2.0.0	4.2	None. Bluetooth module is built-in

To be able to send data via Bluetooth between devices, you must first "pair" and "connect" the devices.

Pair
Connect
Data Exchange

In Bluetooth terminology, "pairing" is the process of making two devices known to each other. Pairing remote devices can be done in two ways because the process can be initiated from either device. In the following sections, we provide examples on how to pair and connect devices for Bluetooth.

NOTE All tools used in the following example can be found in the **bluez** package available on the computer. Use the **#sudo apt-get install wireless-tools** command to install the Wi-Fi utility. You can install the bluez package using the command **# apt-get install bluez**.

Paring Devices

In this example, we describe how to pair two UC-3111-T-US-LX devices (Device A and Device B) for Bluetooth connectivity.

Step 1:

Run the **bluetoothctl** command on both Device A and Device B.

Device A

```
root@Moxa:/home/moxa# bluetoothctl
[NEW] Controller 0C:1C:57:B7:B7:7B Moxa [default]
[bluetooth]#
```

Device B

```
root@Moxa:/home/moxa# bluetoothctl
[NEW] Controller C8:DF:84:4A:67:3F Moxa [default]
[bluetooth]#
```

We can see from the console output that the MAC address of Device A is **0C:1C:57:B7:B7:7B** and the MAC address of Device B is **C8:DF:84:4A:67:3F**.

Step 2:

Set Device A to **discoverable** and initiate scanning on Device B to find Device A.

NOTE

- You can use the **system-alias** command to assign a name to a device so it can be identified easily when it is discovered by other device.
- You can set the **discoverable** status to **off** or **scan** status to **off** at any time.

Device A

```
[bluetooth]# system-alias Device A
Changing Device A succeeded
[CHG] Controller 0C:1C:57:B7:B7:7B Alias: Device A
[bluetooth]# discoverable on
Changing discoverable on succeeded
[CHG] Controller 0C:1C:57:B7:B7:7B Discoverable: yes
```

Device B

```
[bluetooth]# system-alias Device B
Changing Device B succeeded
[CHG] Controller C8:DF:84:4A:67:3F Alias: Device B
[bluetooth]# scan on
Discovery started
[CHG] Controller C8:DF:84:4A:67:3F Discovering: yes
[NEW] Device 0C:1C:57:B7:B7:7B Device A
```

Device A is discovered by Device B.

Step 3:

Use the **pair** command to pair the two devices.

Device A

```
[NEW] Device C8:DF:84:4A:67:3F Device B
[CHG] Device C8:DF:84:4A:67:3F Modalias: usb:v1D6Bp0246d052B
[CHG] Device C8:DF:84:4A:67:3F UUIDs: 0000110c-0000-1000-8000-00805f9b34fb
[CHG] Device C8:DF:84:4A:67:3F UUIDs: 0000110e-0000-1000-8000-00805f9b34fb
[CHG] Device C8:DF:84:4A:67:3F UUIDs: 00001200-0000-1000-8000-00805f9b34fb
[CHG] Device C8:DF:84:4A:67:3F UUIDs: 00001800-0000-1000-8000-00805f9b34fb
[CHG] Device C8:DF:84:4A:67:3F UUIDs: 00001801-0000-1000-8000-00805f9b34fb
[CHG] Device C8:DF:84:4A:67:3F ServicesResolved: yes
[CHG] Device C8:DF:84:4A:67:3F Paired: yes
[CHG] Device C8:DF:84:4A:67:3F ServicesResolved: no
[CHG] Device C8:DF:84:4A:67:3F Connected: no
[bluetooth]# quit
[DEL] Controller 0C:1C:57:B7:B7:7B Device A [default]
```

Device B

```
[bluetooth]# pair 0C:1C:57:B7:B7:7B
Attempting to pair with 0C:1C:57:B7:B7:7B
[CHG] Device 0C:1C:57:B7:B7:7B Connected: yes
[CHG] Device 0C:1C:57:B7:B7:7B UUIDs: 0000110c-0000-1000-8000-00805f9b34fb
[CHG] Device 0C:1C:57:B7:B7:7B UUIDs: 0000110e-0000-1000-8000-00805f9b34fb
[CHG] Device 0C:1C:57:B7:B7:7B UUIDs: 00001200-0000-1000-8000-00805f9b34fb
[CHG] Device 0C:1C:57:B7:B7:7B UUIDs: 00001800-0000-1000-8000-00805f9b34fb
[CHG] Device 0C:1C:57:B7:B7:7B UUIDs: 00001801-0000-1000-8000-00805f9b34fb
[CHG] Device 0C:1C:57:B7:B7:7B ServicesResolved: yes
[CHG] Device 0C:1C:57:B7:B7:7B Paired: yes
Pairing successful
[CHG] Device 0C:1C:57:B7:B7:7B ServicesResolved: no
[CHG] Device 0C:1C:57:B7:B7:7B Connected: no
[bluetooth]# quit
[DEL] Controller C8:DF:84:4A:67:3F Device B [default]
```

After the two devices are paired successfully, use the **quit** command to exit the bluetoothctl program.

Connecting Devices

After the two devices are paired, the next step is to connect them for Bluetooth.

Step 1:

Use the **hciconfig** command to check device names.

Device A

```
root@Moxa:/home/moxa# hciconfig
hci0:   Type: Primary  Bus: UART
  BD Address: 0C:1C:57:B7:B7:7B  ACL MTU: 1021:6  SCO MTU: 180:4
  UP RUNNING PSCAN
  RX bytes:2166 acl:16 sco:0 events:91 errors:0
  TX bytes:3781 acl:16 sco:0 commands:61 errors:0
```

Device B

```
root@Moxa:/home/moxa# hciconfig
hci0:   Type: Primary  Bus: UART
  BD Address: C8:DF:84:4A:67:3F  ACL MTU: 1021:6  SCO MTU: 180:4
  UP RUNNING PSCAN
  RX bytes:8521 acl:16 sco:0 events:509 errors:0
  TX bytes:6186 acl:16 sco:0 commands:350 errors:0
```

The Bluetooth device name for both Device A and Device is **`hci0`**.

Step 2:

Connect the two devices using the **`rfcomm`** tool.

a. Set Device A to "listen state" so that Device B can connect.

b. From Device B, connect to the MAC address of Device A.

Device A

```
root@Moxa:/home/moxa# rfcomm -i hci0 listen /dev/rfcomm0
Waiting for connection on channel 1
Connection from C8:DF:84:4A:67:3F to /dev/rfcomm0
Press CTRL-C for hangup
```

Device B

```
root@Moxa:/home/moxa# rfcomm -i hci0 connect /dev/rfcomm0 0C:1C:57:B7:B7:7B
Connected /dev/rfcomm0 to 0C:1C:57:B7:B7:7B on channel 1
Press CTRL-C for hangup
```

The devices can now communicate over the **`/dev/rfcomm0`** interface.

Step 3:

Test the connection between the devices over the **`/dev/rfcomm0`** interface.

Device A

```
root@Moxa:/home/moxa# echo "123" > /dev/rfcomm0
```

Device B

```
root@Moxa:/home/moxa# cat /dev/rfcomm0
123
```

Additional References

- BlueZ
- bluetoothctl man page
- rfcomm man page

5

Security

Moxa’s Arm-based computers offer better security by introducing Moxa’s innovative secure boot feature, and the integration of a Trusted Platform Module gives the user more solid protection for the platform.

The following topics are covered in this chapter:

Sudo Mechanism

In Moxa Arm-based computers, the root account is disabled in favor of better security. Sudo is a program designed to let system administrators allow permitted users to execute some commands as the root user or another user. The basic philosophy is to give as few privileges as possible but still allow people to get their work done. Using sudo is better (safer) than opening a session as root for a number of reasons, including:

- Nobody needs to know the root password (sudo prompts for the current user's password). Extra privileges can be granted to individual users temporarily, and then taken away without the need for a password change.
- It is easy to run only the commands that require special privileges via sudo; the rest of the time, you work as an unprivileged user, which reduces the damage caused by mistakes.
- Some system-level commands are not available to the user **moxa** directly, as shown in the sample output below:

```
moxa@Moxa:~$ ifconfig
-bash: ifconfig: command not found

moxa@Moxa:~$ sudo ifconfig
eth0     Link encap:Ethernet  HWaddr 00:90:e8:00:00:07
        inet addr:192.168.3.127  Bcast:192.168.3.255  Mask:255.255.255.0
        UP BROADCAST ALLMULTI MULTICAST  MTU:1500  Metric:1
        RX packets:0 errors:0 dropped:0 overruns:0 frame:0
        TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
        collisions:0 txqueuelen:1000
        RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

eth1     Link encap:Ethernet  HWaddr 00:90:e8:00:00:08
        inet addr:192.168.4.127  Bcast:192.168.4.255  Mask:255.255.255.0
        UP BROADCAST ALLMULTI MULTICAST  MTU:1500  Metric:1
        RX packets:0 errors:0 dropped:0 overruns:0 frame:0
        TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
        collisions:0 txqueuelen:1000
        RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
        inet addr:127.0.0.1  Mask:255.0.0.0
        inet6 addr: ::1/128 Scope:Host
        UP LOOPBACK RUNNING  MTU:16436  Metric:1
        RX packets:32 errors:0 dropped:0 overruns:0 frame:0
        TX packets:32 errors:0 dropped:0 overruns:0 carrier:0
        collisions:0 txqueuelen:0
        RX bytes:2592 (2.5 KiB)  TX bytes:2592 (2.5 KiB)
```

6

System Boot Up, Recovery, and Update

The following topics are covered in this chapter:

Set-to-default Functions

Set-to-default

Press and hold the reset button between 7 to 9 seconds to reset the computer to the factory default settings. When the reset button is held down, the LED will blink once every second. The LED will become steady when you hold the button continuously for 7 to 9 seconds. Release the button within this period to load the factory default settings. For additional details on the LEDs, refer to the quick installation guide or the user's manual for your Arm-based computer.

ATTENTION

Reset-to-default will erase all the data stored on the boot storage
Please back up your files before resetting the system to factory defaults. All the data stored in the Arm-based computer's boot storage will be destroyed after resetting to factory defaults.

You can also use the **mx-set-def** command to restore the computer to factory default:

```
moxa@Moxa:~$ sudo mx-set-def
```

Firmware Update Using a TFTP Server

Preparing the TFTP Server

1. Set up a TFTP server.
2. Make sure the image (*.img) file is in your TFTP server directory.

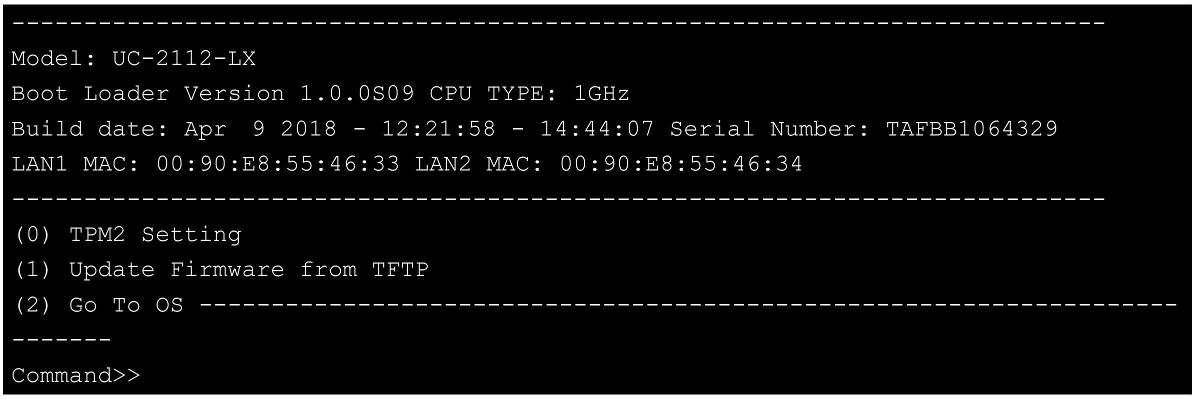
IMPORTANT!

Use this method to upgrade the firmware on your computer if the size of the firmware file is less than 2 GB. If the file size is more than 2 GB, use the SD card to upgrade the firmware.

Updating the Firmware

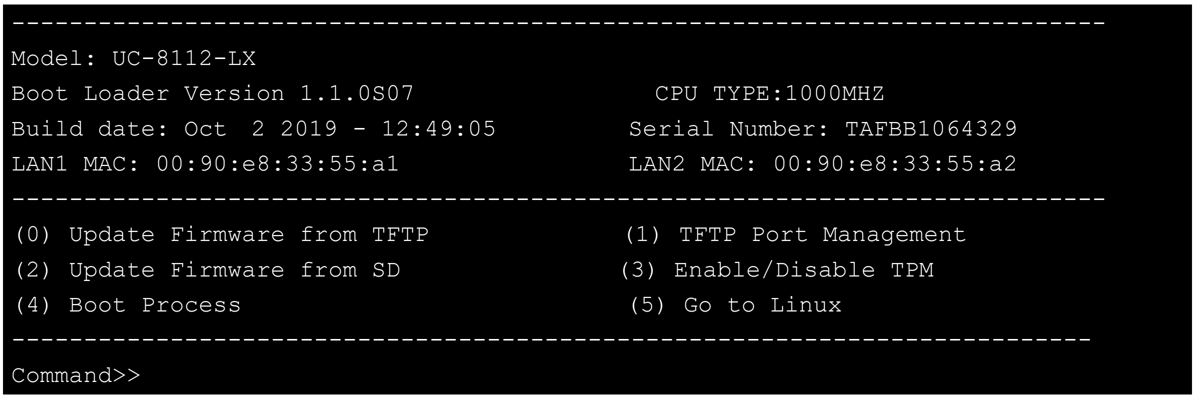
1. To update the firmware, log in to the product through the serial console. Instructions on how to connect to the serial console can be found in the Hardware user's manual for your Arm-based computer.
2. After powering on the computer, press <DEL> or <Backspace>to enter the bootloader configuration settings.

NOTE If you cannot enter the bootloader menu by pressing <DEL>, replace the PuTTy tool with the Tera Term terminal console tool (detailed information is available at: https://ttssh2.osdn.jp/index.html.en.)



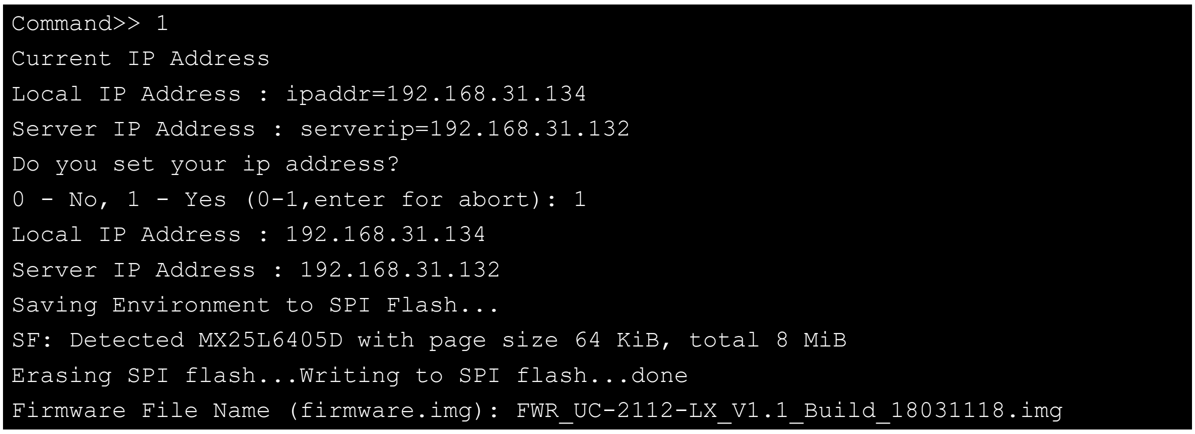
```
----------------------------------------------------------------------------
Model: UC-2112-LX
Boot Loader Version 1.0.0S09 CPU TYPE: 1GHz
Build date: Apr  9 2018 - 12:21:58 - 14:44:07 Serial Number: TAFBB1064329
LAN1 MAC: 00:90:E8:55:46:33 LAN2 MAC: 00:90:E8:55:46:34
----------------------------------------------------------------------------
(0) TPM2 Setting
(1) Update Firmware from TFTP
(2) Go To OS ---------------------------------------------------------------------
-------
Command>>
```

Some computers support additional functions, as follows:



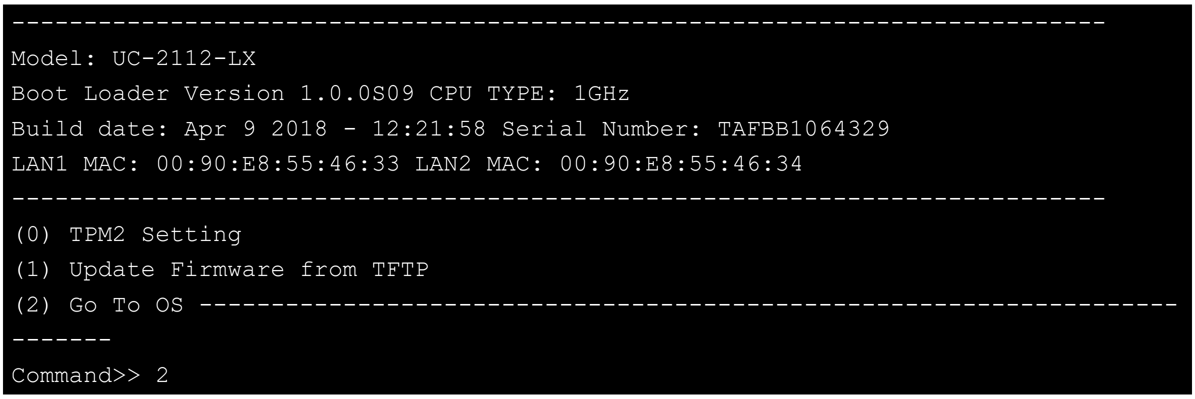
```
----------------------------------------------------------------------------
Model: UC-8112-LX
Boot Loader Version 1.1.0S07                 CPU TYPE:1000MHZ
Build date: Oct  2 2019 - 12:49:05          Serial Number: TAFBB1064329
LAN1 MAC: 00:90:e8:33:55:a1                 LAN2 MAC: 00:90:e8:33:55:a2
----------------------------------------------------------------------------
(0) Update Firmware from TFTP               (1) TFTP Port Management
(2) Update Firmware from SD                (3) Enable/Disable TPM
(4) Boot Process                            (5) Go to Linux
---------------------------------------------------------------------------
Command>>
```

3. Use **TFTP Port Management** to specify the LAN port to be used for TFTP transfer.
4. Select **Update Firmware from TFTP** if you want to set up the TFTP IP address, enter 1 to set up the target machine's IP address and the TFTP server IP address and then choose an img file.



```
Command>> 1
Current IP Address
Local IP Address : ipaddr=192.168.31.134
Server IP Address : serverip=192.168.31.132
Do you set your ip address?
0 - No, 1 - Yes (0-1,enter for abort): 1
Local IP Address : 192.168.31.134
Server IP Address : 192.168.31.132
Saving Environment to SPI Flash...
SF: Detected MX25L6405D with page size 64 KiB, total 8 MiB
Erasing SPI flash...Writing to SPI flash...done
Firmware File Name (firmware.img): FWR_UC-2112-LX_V1.1_Build_18031118.img
```

5. After updating the firmware, select **Go to OS** or **Go to Linux** to open the OS command-line console.



```
----------------------------------------------------------------------------
Model: UC-2112-LX
Boot Loader Version 1.0.0S09 CPU TYPE: 1GHz
Build date: Apr 9 2018 - 12:21:58 Serial Number: TAFBB1064329
LAN1 MAC: 00:90:E8:55:46:33 LAN2 MAC: 00:90:E8:55:46:34
----------------------------------------------------------------------------
 (0) TPM2 Setting
 (1) Update Firmware from TFTP
 (2) Go To OS --------------------------------------------------------------------
-------
Command>> 2
```

Firmware Update via APT

To update the firmware packages, follow the instructions at:

https://www.notion.so/How-to-upgrade-your-Moxa-computer-device-2f80bde1ef5f432ca1a9919d824a9e1c

Creating a Customized Firmware Image

To create a customized firmware image for your computer, follow the instructions at:

https://github.com/Moxa-Linux/resize-image

Boot-up Option

Changing the Default Boot-up Option

By default, the UC series computers boot up from the embedded eMMC flash. Some models also provide an option to boot up from an external SD card. A list of the models that support the additional boot option are listed below:

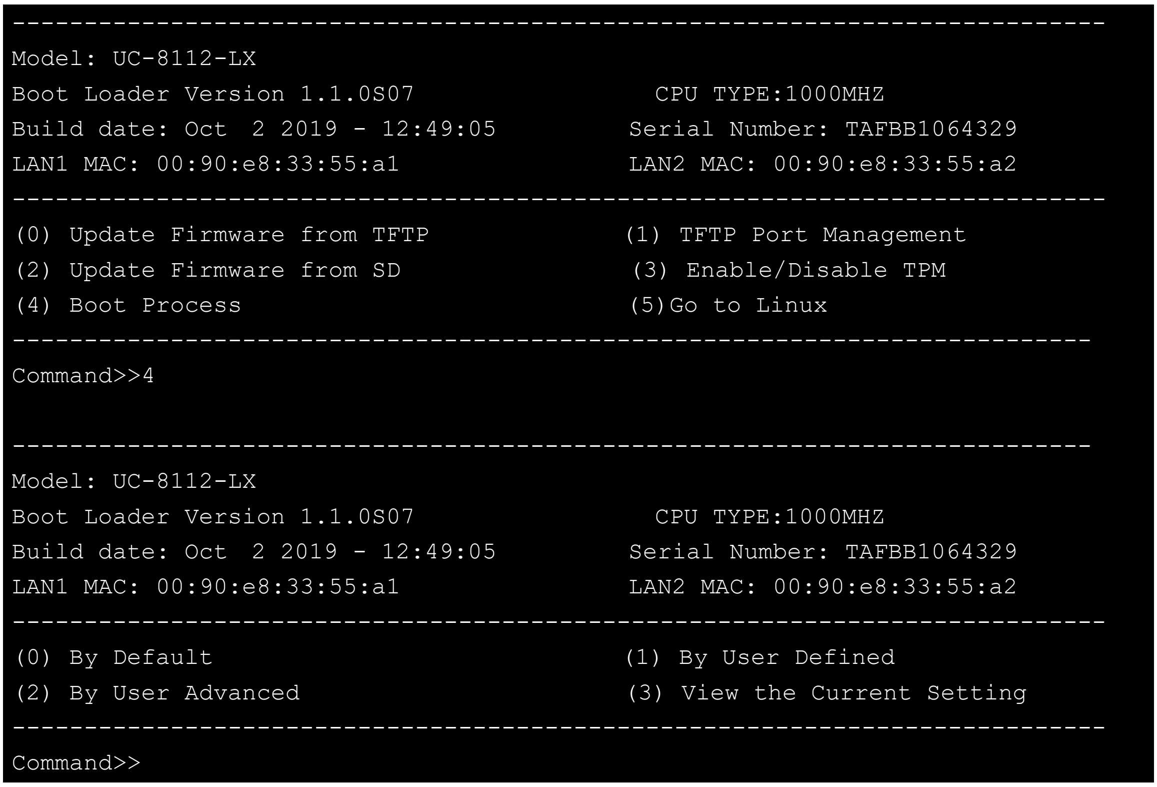
Computer Series	Hardware Revision
UC-8100-LX Series	V3.1.0 and above
UC-8410A Series	V2.1.0 and above
UC-8200 Series	V1.0.0 and above
UC-5100 Series	V1.0.0 (with bootloader v1.1) and above

ATTENTION

In the case of the UC-8410A Series, the system may fail to boot from an SD card if a USB storage device is also plugged in. Please remove any plugged-in USB storage devices before booting from an SD card.

To change the default boot-up option, do the following:

1. Select **Boot Process** from bootloader menu.



```
----------------------------------------------------------------------------
Model: UC-8112-LX
Boot Loader Version 1.1.0S07                  CPU TYPE:1000MHZ
Build date: Oct  2 2019 - 12:49:05          Serial Number: TAFBB1064329
LAN1 MAC: 00:90:e8:33:55:a1                 LAN2 MAC: 00:90:e8:33:55:a2
----------------------------------------------------------------------------
(0) Update Firmware from TFTP              (1) TFTP Port Management
(2) Update Firmware from SD                 (3) Enable/Disable TPM
(4) Boot Process                            (5)Go to Linux
---------------------------------------------------------------------------
Command>>4

---------------------------------------------------------------------------
Model: UC-8112-LX
Boot Loader Version 1.1.0S07                  CPU TYPE:1000MHZ
Build date: Oct  2 2019 - 12:49:05          Serial Number: TAFBB1064329
LAN1 MAC: 00:90:e8:33:55:a1                 LAN2 MAC: 00:90:e8:33:55:a2
----------------------------------------------------------------------------
(0) By Default                             (1) By User Defined
(2) By User Advanced                        (3) View the Current Setting
----------------------------------------------------------------------------
Command>>
```

2. Select the boot-up option.

   The boot-up options are described below:

   By Default

   Sets the boot option to **default**, which is boot up from the embedded eMMC flash.

   By User Defined

   This option provides a simple way to change the boot order between the embedded eMMC and external SD card.

Set Boot Order	Set Embedded Storage	Set External Storage	Result
0 – Embedded First	1 – eMMC	0 – Disabled	Boot from the eMMC
1 – External First	0 – Disabled	1 – SD	Boot from the SD card
0 – Embedded First	1 – eMMC	1 – SD	First boot from the eMMC; if it fails, try to boot from the SD card
1 – External First	1 – eMMC	1 – SD	Boot from the SD card; if this fails, try to boot from eMMC

   By User Advanced

   Enables advanced users to edit the **bootargs** and **bootcmd** parameters to customize the boot process.

   - **bootargs**: Used to tell the kernel how to configure various device drivers and where to find the root filesystem.
   - **bootcmd**: Bootloader will execute the commands listed sequentially. Commands should be separated by semicolons.

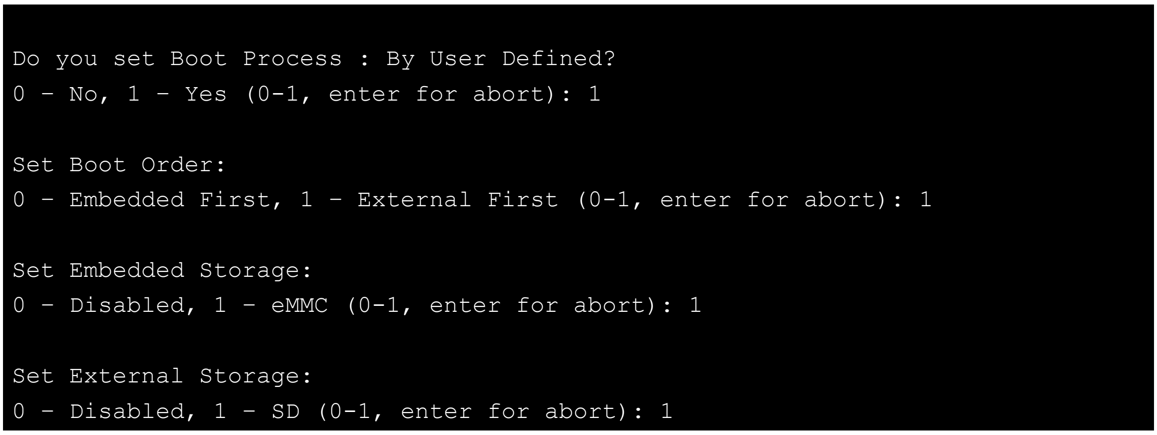
View the Current Settings

Displays the current boot-process setting.

3. Power off and power on the computer.

   The bootloader will boot up the computer according to the new setting.

   In the following example, the boot-up process will first try to boot up the computer from the SD card. If boot up from the SD card fails, the computer will boot up from the eMMC flash.

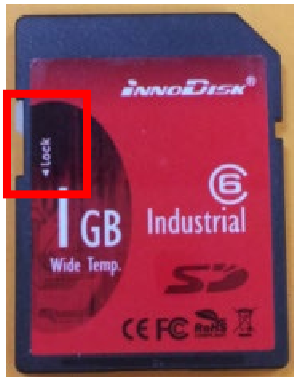


```
Do you set Boot Process : By User Defined?
0 - No, 1 - Yes (0-1, enter for abort): 1

Set Boot Order:
0 - Embedded First, 1 - External First (0-1, enter for abort): 1

Set Embedded Storage:
0 - Disabled, 1 - eMMC (0-1, enter for abort): 1

Set External Storage:
0 - Disabled, 1 - SD (0-1, enter for abort): 1
```

Preparing a Bootable SD Card

Windows System

1. Unlock the SD card's write protection switch.



2. Insert the SD card into the corresponding slot on your Windows system.
3. Download **win32diskimager** from following link.

   http://sourceforge.net/projects/win32diskimager/

4. Install and run the **win32diskimager**.
5. Confirm that the device name matches the USB device.

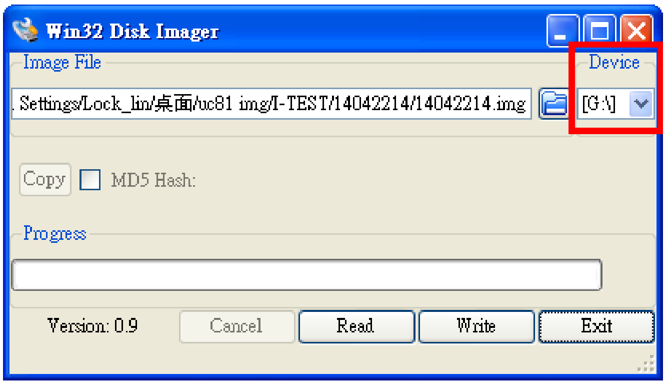
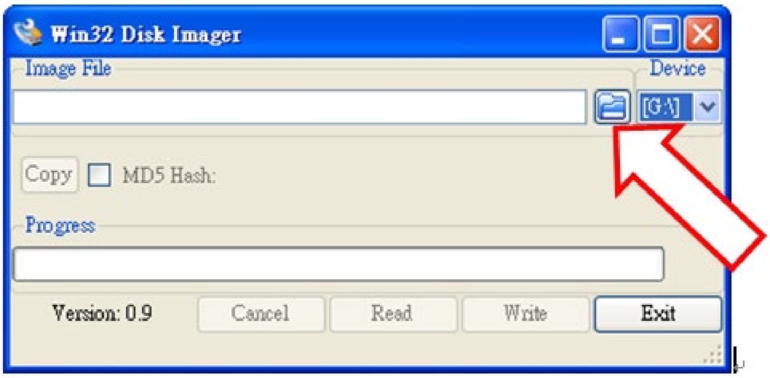


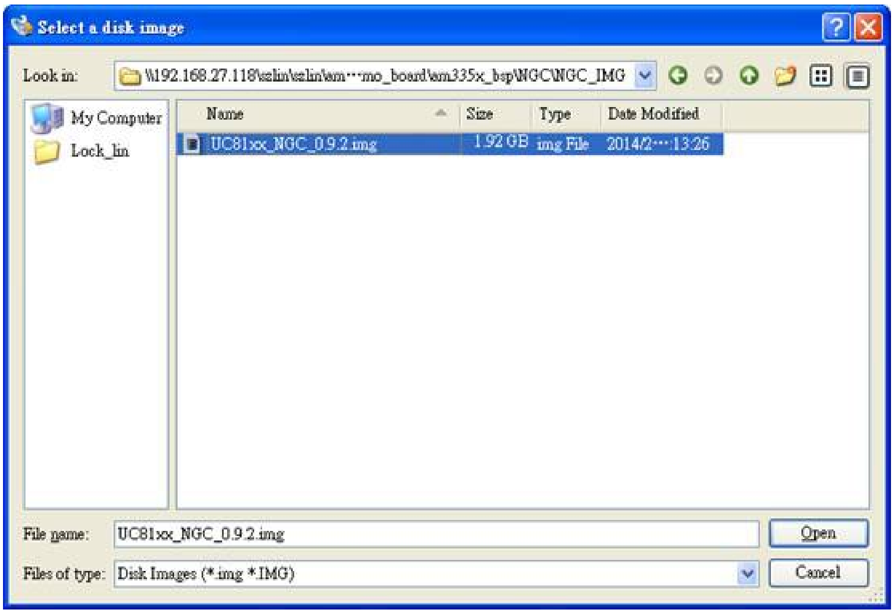
Image File: Settings/Lock_lin/桌面/uc81 img/I-TEST/14042214/14042214.img

Device: [G:\]

Version: 0.9

6. Select the image file.





Look in: \\192.168.27.118\szlin\szlin\am···mo_board\am335x_bsp\NGC\NGC_IMG

Name	Size	Type	Date Modified
UC81xx_NGC_0.9.2.img	1.92 GB	img File	2014/2···13:26

File name: UC81xx_NGC_0.9.2.img

Files of type: Disk Images (*.img *.IMG)

7. Confirm that you have selected the correct image file and click **Write**.

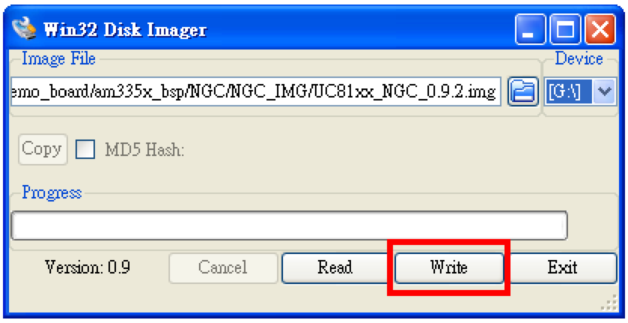


Image File: emo_board/am335x_bsp/NGC/NGC_IMG/UC81xx_NGC_0.9.2.img

Device: [G:\]

Version: 0.9

8. When finished, click **OK**.

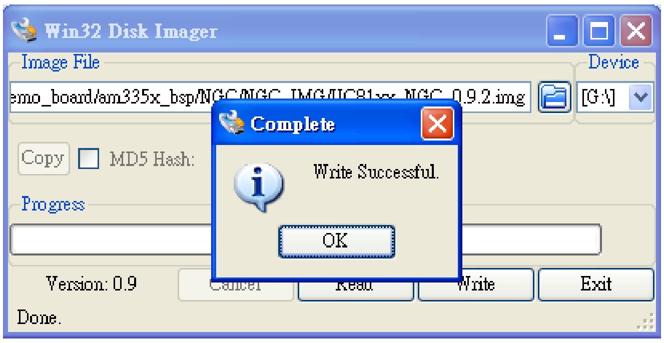


Image File: emo_board/am335x_bsp/NGC/NGC_IMG/UC81xx_NGC_0.9.2.img

Device: [G:\]

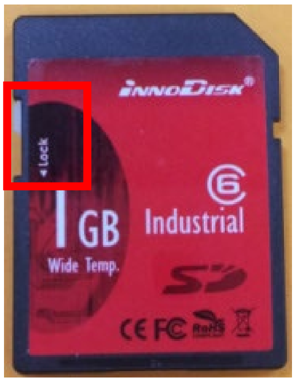
Write Successful.

Version: 0.9

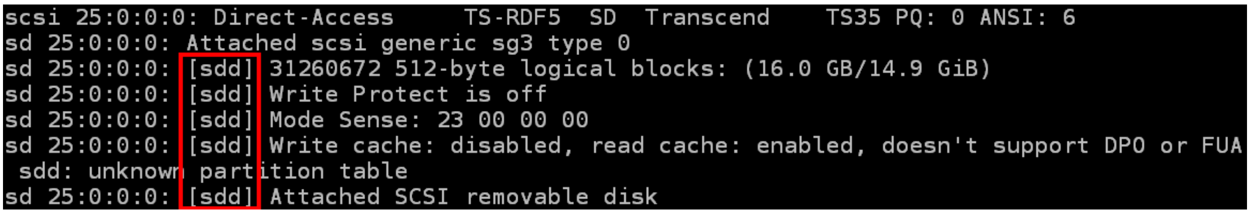
Done.

Linux System

1. Unlock the SD card’s write protection switch.



2. Insert the SD card into the corresponding slot on you Linux system.
3. Use the **dmesg** command to determine the device node.



```
scsi 25:0:0:0: Direct-Access     TS-RDF5  SD  Transcend    TS35 PQ: 0 ANSI: 6
sd 25:0:0:0: Attached scsi generic sg3 type 0
sd 25:0:0:0: [sdd] 31260672 512-byte logical blocks: (16.0 GB/14.9 GiB)
sd 25:0:0:0: [sdd] Write Protect is off
sd 25:0:0:0: [sdd] Mode Sense: 23 00 00 00
sd 25:0:0:0: [sdd] Write cache: disabled, read cache: enabled, doesn't support DPO or FUA
 sdd: unknown partition table
sd 25:0:0:0: [sdd] Attached SCSI removable disk
```

4. Use the dd command to configure the image on the SD card.

```
moxa@Moxa:/home/work# sudo dd if=./140
42420.img of=/dev/sdd
bs=512k
       1954+0 records in
1954+0 records out
1024458752 bytes (1.0 GB) copied, 119.572 s, 8.6 MB/s
```

NOTE For additional information on the **dd** command, click the following link.
http://www.gnu.org/software/coreutils/manual/html_node/dd-invocation.html

7

Programmer's Guide

The following topics are covered in this chapter:

- ❒ **Building an Application**
  - ➢ Introduction
  - ➢ Native Compilation
  - ➢ Cross Compilation
  - ➢ Example Program—hello
  - ➢ Example Makefile
- ❒ **Standard APIs**
  - ➢ Cryptodev
  - ➢ Watchdog Timer (WDT)
  - ➢ Real-time Clock (RTC)
  - ➢ Modbus
- ❒ **ECO Mode for Power Consumption**
  - ➢ Using mx-power-mgmt
  - ➢ Scheduled Awakening Mode
  - ➢ Conservation Mode
  - ➢ Setting the SYS LEDs Using mx-power-mgmt
  - ➢ Wake-up From Conservation Mode
  - ➢ MCU Firmware Upgrade
  - ➢ Checking the MCU mode
  - ➢ Viewing the Utility and MCU Firmware Version
  - ➢ User-defined Actions
- ❒ **Moxa Platform Libraries**
  - ➢ Error Numbers
  - ➢ Platform Information
  - ➢ Buzzer
  - ➢ Digital I/O
  - ➢ UART
  - ➢ LED
  - ➢ Push Button

Building an Application

Introduction

Moxa's Arm-based computers support both native and cross-compiling of code. Native compiling is more straightforward since all the coding and compiling can be done directly on the device. However, Arm architecture is less powerful and hence the compiling speed is slower. To overcome this, you can cross compile your code on a Linux machine using a toolchain; the compiling speed is much faster.

Native Compilation

Follow these steps to update the package menu:

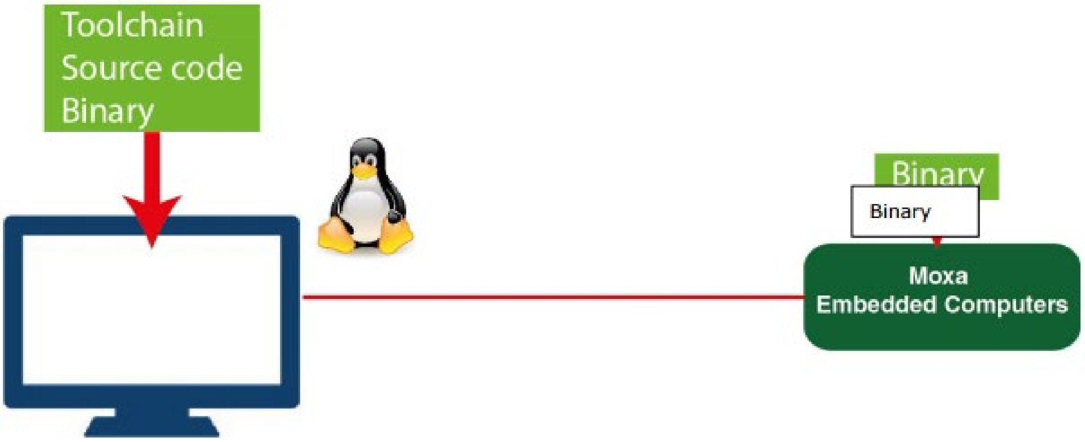
1. Make sure a network connection is available.
2. Use **`apt-get update`** to update the Debian package list.

```
moxa@Moxa:~$ sudo apt-get update
```

3. Install the native compiler and necessary packages.

```
moxa@Moxa:~$ sudo apt-get install gcc build-essential flex bison automake
```

Cross Compilation



Moxa Industrial Linux (MIL) in Moxa's Arm-based computers is based on Debian. So, we recommend setting up a Debian environment on the host device to ensure best compatibility during cross compilation.

The toolchain will need about 300 MB of hard disk space on your PC.

To cross compile your code, do the following:

1. Set up a Debian 9 environment using a VM or Docker.
2. Add the Moxa Debian repository to the apt source list.

   Open **moxa.source.list** in the vi editor.

```
user@Linux:~$ sudo vi /etc/apt/sources.list.d/moxa.sources.list
```

   Add the following line to **moxa.source.list**:

   `deb http://debian.moxa.com/debian stretch main contrib non-free`

3. Update the apt information.

```
user@Linux:~$ apt-get update
```

4. (Optional) During the update process, if you don't want to see messages related to "server certificate verification failed", you can install Moxa apt **keyring**. These messages, however, will not affect the operation.

   ```
   user@Linux:~$ apt-get install moxa-archive-keyring
   ```

5. Update the apt information again.

   ```
   user@Linux:~$ apt-get update
   ```

6. In order to install non-amd64 packages, such as armhf and u386, add the external architecture. In the example, we are adding the armhf architecture.

   ```
   user@Linux:~$ dpkg --add-architecture armhf
   ```

7. Download the toolchain file from apt server (all Moxa UC series computers use the official Debian toolchain).

   ```
   user@Linux:~$ apt-get install crossbuild-essential-armhf
   ```

8. Install **dev** or **lib** packages depending on whether Debian or Moxa packages are applicable for the procedure.

   Example for installing a Moxa package:

   ```
   user@Linux:~$ apt-get install libmoxa-uart-control-dev:armhf
   ```

   Example for installing a Debian official package:

   ```
   user@Linux:~$ apt-get install libssl-dev:armhf
   ```

You can now start compiling programs using the toolchain.

NOTE For all available libraries and headers offered by Debian, visit: https://packages.debian.org/index

Example Program—hello

In this section, we use the standard "hello" example program to illustrate how to develop a program for Moxa computers. All example codes can be downloaded from Moxa’s website. The "hello" example code is available in the **hello** folder; hello/hello.c:

```
#include <stdio.h>

int main(int argc, char *argv[])
{
    printf("Hello World\n");
    return 0;
}
```

Native Compilation

1. Compile the hello.c code.

```
moxa@Moxa:~$ gcc -o hello hello.c
moxa@Moxa:~$ strip -s hello
```

or

use the Makefile as follows:

```
moxa@Moxa:~$ make
```

2. Run the program.

```
moxa@Moxa:~$ ./hello
Hello World
```

Cross Compiling

1. Compile the hello.c code.

```
user@Linux:~$ arm-linux-gnueabihf-gcc -o hello \
    hello.c
user@Linux:~$ arm-linux-gnueabihf-strip -s hello
```

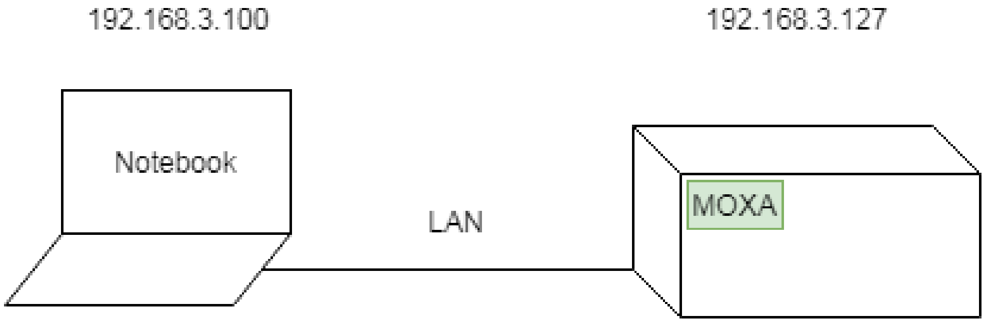
or

use the Makefile as follows:

```
user@Linux:~$ make CC=arm-linux-gnueabihf-gcc \
    STRIP=arm-linux-gnueabihf-strip
```

2. Copy the program to a Moxa computer:

For example, if the IP address of your device used for cross compiling the code is "192.168.3.100" and the IP address of the Moxa computer is "192.168.3.127", use the following command:



```
user@Linux:~$ scp hello moxa@192.168.3.127:~
```

3. Run the hello.c program on the Moxa computer.

```
moxa@Moxa:~$ ./hello
Hello World
```

Example Makefile

You can create a Makefile for the "hello" example program using the following code. By default, the Makefile is set for native compiling.

"hello/Makefile":

```
CC:=gcc
STRIP:=strip

all:
    $(CC) -o hello hello.c
    $(STRIP) -s hello

.PHONY: clean
clean:
    rm -f hello
```

To set the hello.c program for cross compilation, modify the toolchain settings as follows:

```
CC:=arm-linux-gnueabihf-gcc
STRIP:=arm-linux-gnueabihf-strip
```

Standard APIs

This section shows how to use some standard APIs on Moxa computers.

Cryptodev

The purpose of cryptographic hardware accelerator is to load off the intensive encryption/decryption and compression/decompression tasks from CPU.

Cryptodev-linux is a device that allows access to Linux kernel cryptographic drivers; thus allowing the userspace applications to take advantage of hardware accelerators. Cryptodev-linux uses "/dev/crypto" interface to let kernel space hardware accelerator drivers become accessible from typical userspace programs and libraries.

Example Code

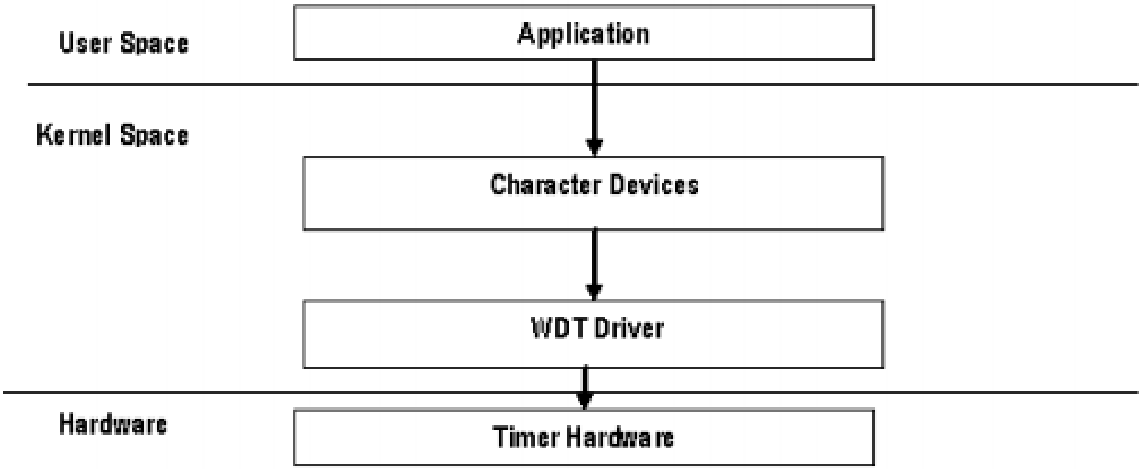
The cryptodev example code is available in the **cryptodev** folder.

Cryptodev-linux APIs are defined in <crypto/cryptodev.h>.

NOTE Need to install Linux kernel header.
More information are available at Cryptodev-linux document: http://cryptodev-linux.org/documentation.html

Watchdog Timer (WDT)

The WDT works like a watchdog function. You can enable it or disable it. When the WDT is enabled, but the application does not acknowledge it, the system will reboot. You can set the ack time from a minimum of 1 sec to a maximum of 1 day. The default timer is 60 seconds and the NO WAY OUT is enabled by default; there is no way to disable the watchdog once it has been started. For this reason, if the watchdog daemon crashes, the system will reboot after the timeout has passed.



Config

You need to know which driver you're using first. Assume that the watchdog driver's name is "ds1374_wdt", then you can use the **modinfo** command to check the information as follows:

```
moxa@Moxa:~$ sudo modinfo ds1374_wdt
filename:       /lib/modules/4.4.0-cip-
uc5100+/kernel/drivers/watchdog/ds1374_wdt.ko
license:        GPL
description:     Maxim/Dallas DS1374 WDT Driver
author:         Scott Wood <scottwood@freescale.com>
depends:
intree:         Y
vermagic:       4.4.0-cip-uc5100+ mod_unload ARMv7 p2v8
parm:          nowayout:Watchdog cannot be stopped once started, default=0 (bool)
parm:          timer_margin:Watchdog timeout in seconds (default 60s) (int)
```

The parameter's name is "nowayout" for NO WAY OUT and "timer_margin" for timeout setting. To change the setting, you can add a conf file under the directory "/etc/modprobe.d/". For example, add a file "/etc/modprobe.d/watchdog.conf" with the following content:

```
options ds1374_wdt nowayout=1 timer_margin=60
```

This changes the setting for "ds1374_wdt" driver with nowayout=1 and timeout=60 seconds.

Example Code

The example code is available in the **watchdog** folder.

WDT driver APIs are used via "ioctl" through a file descriptor. The methods are defined in <linux/watchdog.h>.

The watchdog device node locate at "/dev/watchdog".

```
int fd = open("/dev/watchdog", O_WRONLY);
if (fd < 0) {
    perror("open watchdog failed");
    exit(EXIT_FAILURE);
}
```

API List

IOCTL Function	WDIOC_KEEPALIVE
Description	Writes to the watchdog device to keep the watchdog alive
Example	ioctl(fd, WDIOC_KEEPALIVE, 0);

IOCTL Function	WDIOC_GETTIMEOUT
Description	Queries the current timeout

Example	int timeout;
	ioctl(fd, WDIOC_GETTIMEOUT, &timeout);

IOCTL Function	WDIOC_SETTIMEOUT
Description	Modifies the watchdog timeout Min: 1 second. Max: 1 day; Default: 60 seconds

Example	int timeout = 60;
	ioctl(fd, WDIOC_SETTIMEOUT, &timeout);

IOCTL Function	WDIOC_GETSTATUS
Description	Asks for the current status

Example	int flags;
	ioctl(fd, WDIOC_GETSTATUS, &flags);

IOCTL Function	WDIOC_SETOPTIONS
Description	Control some aspects of the cards operation • WDIOS_DISABLECARD: Turn off the watchdog timer • WDIOS_ENABLECARD: Turn on the watchdog timer • WDIOS_TEMPPANIC: Kernel panic on temperature trip

Example	int options = WDIOS_DISABLECARD;
	ioctl(fd, WDIOC_SETOPTIONS, &options);

IOCTL Function	WDIOC_GETSUPPORT
Description	Asks what the device can do

Example	struct watchdog_info ident;
	ioctl(fd, WDIOC_GETSUPPORT, &ident);

NOTE More information are available at Linux kernel document:
https://www.kernel.org/doc/Documentation/watchdog/watchdog-api.txt

Real-time Clock (RTC)

The Real-time Clock is a computer clock that keeps track of the current time. RTC can be used to complete time critical tasks. Using RTC can benefit from its lower power consumption and higher accuracy.

Example Code

The RTC example code is available in the **rtc** folder.

RTC APIs are used via "ioctl" through a file descriptor. The methods are defined in <linux/rtc.h>.

The rtc device node locate at "/dev/rtc0".

The APIs that read time from RTC and set RTC time are using a structure "struct rtc_time". It is defined in <linux/rtc.h>:

```
struct rtc_time {
    int tm_sec;
    int tm_min;
    int tm_hour;
    int tm_mday;
    int tm_mon;
    int tm_year;
    int tm_wday;
    int tm_yday;
    int tm_isdst;
};
```

Note that variable "tm_mon" starts with 0 and variable "tm_year" represents the number of years since 1900.

API List

IOCTL Function	RTC_RD_TIME
Description	Reads time information from the RTC; returns the value of argument 3

Example	struct rtc_time rtc_tm;
	ioctl(fd, RTC_RD_TIME, &rtc_tm);

IOCTL Function	RTC_SET_TIME
Description	Sets the RTC time. Argument 3 will be passed to the RTC.

Example	struct rtc_time rtc_tm;
	ioctl(fd, RTC_SET_TIME, &rtc_tm);

NOTE More information are available at Linux kernel document:
https://www.kernel.org/doc/Documentation/rtc.txt

Modbus

The Modbus protocol is a messaging structure used to establish master-slave/client-server communication between intelligent devices. It is a de facto standard, truly open, and the most widely used network protocol in industrial manufacturing environments. It has been implemented by hundreds of vendors on thousands of different devices to transfer discrete/analog I/O and register data between control devices.

Example Code

We use "libmodbus" with current stable version v3.0.6 as our modbus package. The package is also available from the following link: http://libmodbus.org/releases/libmodbus-3.0.6.tar.gz

To run the test program, we first need to build the "libmodbus" library. We can build it simply by running the following commands:

```
$ cd modbus/libmodbus-3.0.6/
$ ./configure && make install
```

After build completes, the test program can be found at "tests" directory. The test program provides 3 types of protocols (tcp/ tcppi/ rtu) which can be set by passing command line arguments.

The test program is client-server modeled. We should run the server program first, and then run the client program from another terminal.

```
$ cd modbus/libmodbus-3.0.6/tests/
$ ./unit-test-server tcp
```

```
$ cd modbus/libmodbus-3.0.6/tests/
$ ./unit-test-client tcp
```

NOTE More information are available at libmodbus document: http://libmodbus.org/documentation/

ECO Mode for Power Consumption

Moxa UC-3100 Series offers 3 operating modes: Active mode, Conservation mode, Scheduled Awakening mode. These modes can be used to optimize power consumption, especially in remote deployments that lack a stable power source. This section explains the procedure to set up the **mx-power-mgmt** utility to enable the ECO mode.

NOTE ECO Mode is only available in UC-3100 Series hardware v.1.0.0 and higher with firmware v1.2 and above required.

Using mx-power-mgmt

To be able to run the **`mx-power-mgmt`** command, you must use **`sudo`** or run the command with the root permission. Use the **`# sudo mx-power-mgmt help`** command to display the menu page.

```
moxa@Moxa:~$ sudo mx-power-mgmt help

Usage:

       mx-power-mgmt [Command]...

Command:
       scheduled-awakening [time]
               Set system to scheduled-awakening mode.
               [time]: a number in range 30 ~ 864000
       conservation [time]
               [time]: a number in range 30 ~ 864000
       red-led [on|off|blink]
               Set MCU red led
       green-led [on|off]
               Set MCU green led
       wake-up
               Wake up from conservation mode
       mcu-upgrade
               Upgrade MCU firmware
       check-mode
               Check MCU current mode
       help
               Show the usage manual
       version
               Show MCU firmware and utility version
moxa@Moxa:~$
```

Scheduled Awakening Mode

If this mode is enabled, the power input to the CPU and cellular module is temporarily cut off until the scheduled wake-up duration (in seconds).

`# sudo mx-power-mgmt scheduled-awakening 30`

```
moxa@Moxa:~$ sudo mx-power-mgmt scheduled-awakening 30
[sudo] password for moxa:
Execute user scheduled-awakening preinstall configuration (Command: /etc/power-
management-utils/config/scheduled_awakening_preinst)
Execute scheduled-awakening function configuration (Command: /etc/power-
management-utils/executable/scheduled_awakening)
```

Conservation Mode

If this mode is enabled, the CPU frequency is reduced to 300 MHz and all I/Os are turned Off except CAN port for UC-3121. But, users can still turn on each I/O individually. The SYS LED will continue to blink as an indication that the computer is under conservation mode.

The computer can be awakened from conservation mode according to the time you set. If you set the timer to 0, the system will remain in the conservation mode until it is woken up by a **`Wake-up`** Command.

# sudo mx-power-mgmt conservation 30

```
moxa@Moxa:~$ sudo mx-power-mgmt conservation 30
[sudo] password for moxa:
Execute user conservation preinstall configuration (Command: /etc/power-
management-utils/config/conservation_preinst)
Execute conservation function configuration (Command: /etc/power-management-
utils/executable/conservation)
Network already stopped
Clearing state...
moxa@Moxa:~$
```

# sudo mx-power-mgmt conservation 0

```
moxa@Moxa:~$ sudo mx-power-mgmt conservation 0
Execute user conservation preinstall configuration (Command: /etc/power-
management-utils/config/conservation_preinst)
Execute conservation function configuration (Command: /etc/power-management-
utils/executable/conservation)
WARNING: If you set timer as 0, it will not wake up automatically
You need to use '# mx-power-mgmt wake-up' command to wake up system by yourself
Do you want to continue? (N/y)
y
Enter into conservation mode
```

Setting the SYS LEDs Using mx-power-mgmt

The SYS LEDs in the UC-3100 computer are connected both to the system and the power management MCU. Hence, you can control the MCU to set the SYS LED through the **mx-power-mgmt** utility. There are two SYS LEDs on the MCU: Green and Red. Before turning on/off the LEDs using the **mx-power-mgmt** utility, make sure that the SYS LEDs are turned off on the system side using the command **# mx-led-ctl -p 1 -i 1 off**. You can then use the following **mx-power-mgmt** commands to control the SYS LEDs.

Function	Command
Turn on the SYS Green LED	**# sudo mx-power-mgmt green-led on**
Turn off the SYS Green LED	**# sudo mx-power-mgmt green-led off**
Turn on the SYS Red LED	**# sudo mx-power-mgmt red-led on**
Turn off the SYS Red LED	**# sudo mx-power-mgmt red-led off**
Set the SYS Red LED to the blinking mode	**# sudo mx-power-mgmt red-led blink**

Wake-up From Conservation Mode

The computer can be awakened from the Conservation mode according to a time interval that you set. If you set the timer interval to 0, the computer will stay in this mode until it is woken up using the **# sudo mx-power-mgmt wake-up** command.

```
moxa@Moxa:~$ sudo mx-power-mgmt wake-up
Execute conservation wake up function configuration (Command: /etc/power-
management-utils/executable/conservation_wake_up)
Execute user conservation wake up postinst configuration (Command: /etc/power-
management-utils/config/conservation_wake_up_postinst)
moxa@Moxa:~$
```

MCU Firmware Upgrade

If there is a new version of the MCU firmware, the system will automatically update the MCU after a reboot following the update of the system using the **`apt-get dist-upgrade`** and **`apt-get upgrade`** commands. You can also manually update the MCU firmware with the following command:

`# sudo mx-power-mgmt mcu-upgrade`

```
moxa@Moxa:~$ sudo mx-power-mgmt mcu-upgrade
Start to upgrade MCU firmware
MCU enter into BSL mode.
Reset MCU
MCU firmware upgrade completed
moxa@Moxa:~$
```

Checking the MCU mode

MCU has four modes: power on, active, scheduled-awakening, and conservation. In general, the power on mode is equivalent to active mode. The difference is that active means that your system is awakened from conservation or scheduled-awakening.

# sudo mx-power-mgmt check-mode

```
moxa@Moxa:~$ sudo mx-power-mgmt check-mode
active mode
moxa@Moxa:~$
```

Viewing the Utility and MCU Firmware Version

# sudo mx-power-mgmt version

```
moxa@Moxa:~$ sudo mx-power-mgmt version
MCU firmware version 1.0.0S04
mx-power-mgmt version 1.0.0
moxa@Moxa:~$
```

User-defined Actions

The **mx-power-mgmt** utility allows customers to specify the I/O peripherals that they want to turn off in the conservation mode (this will affect the power consumption). The utility also supports the execution of user programs before entering the Conservation and Scheduled Awakening modes or start a service to keep a program running after wake-up.

To specify the I/O peripheral that you want to turn off in the conservation mode, modify the following file:

# vi /etc/power-management-utils/config/conservation_config

```
# System Leds
CONFIG_TURN_OFF_LED=y
# System Loading
CONFIG_STOP_WIFI_SIGNALD_SERVICE=y
CONFIG_STOP_CELLULAR_SIGNALD_SERVICE=y
CONFIG_STOP_PUSH_BUTTON_SERVICE=y
CONFIG_LOW_CPU_FREQUENCY=y
# Ethernet
CONFIG_POWER_OFF_ETHERNET_ETH0=y
CONFIG_POWER_OFF_ETHERNET_ETH1=y
```

```
# Cellular Wireless
CONFIG_TURN_OFF_CELLULAR_USB=y
CONFIG_POWER_OFF_CELLULAR=y
# Others
CONFIG_TURN_OFF_USB_BUS=y
CONFIG_PULL_DOWN_GPIO=y
# Wake Up Time
CONFIG_DEFAULT_WAKE_UP_TIME=30

# WiFi Wireless (For UC-3111-LX and UC-3121-LX series model)
CONFIG_POWER_SAVE_WIFI=y
```

To run your own program to back up or shut down your service(s) before entering the Conservation or Scheduled Awakening, edit the following files.

# vi /etc/power-management-utils/config/conservation_preinst

# vi /etc/power-management-utils/config/scheduled_awakening_preinst

To start a service to keep your program running after the system wake-up from Conservation or Scheduled Awakening mode, edit the following files:

e.g. # vi /etc/power-management-utils/config/conservation_wake_up_postinst

e.g. # vi /etc/power-management-utils/config/scheduled_awakening_wake_up_postinst

Moxa Platform Libraries

Moxa provides several libraries for developing customized applications. In this section, we will show how to utilize these libraries.

Example codes are available at: https://github.com/Moxa-Linux

Error Numbers

Moxa defines exclusive error numbers for Moxa libraries. It works with other Moxa library codes, and is useful for checking the result of executing an API.

If you call an API, you can check the return value to take particular action in response.

```
int num_of_interfaces;
ret = mx_get_number_of_interfaces(&num_of_interfaces);
if (ret == E_SYSFUNCERR){
    // do something...
}
```

Usage

- Need package "libmoxa-errno-dev"
- Include header <mx_errno.h>

Error Number List

Name	Value	Description
E_SUCCESS	0	Exit successfully
E_SYSFUNCERR	-1	Error occurs in system functions (e.g. open)
E_INVAL	-2	Invalid input
E_LIBNOTINIT	-3	Library is not initialized
E_UNSUPCONFVER	-4	Config version is not supported for the library
E_CONFERR	-5	Error in config file
E_GPIO_NOTEXP	-20	The GPIO is not exported
E_GPIO_UNKDIR	-21	Unknown GPIO direction get
E_GPIO_UNKVAL	-22	Unknown GPIO value get
E_BUZZER_PLAYING	-30	The buzzer is already playing
E_UART_NOTOPEN	-50	The UART port is not opened
E_UART_GPIOIOCTLINCOMP	-51	GPIO and IOCTL are incompatible for UART
E_UART_UNKMODE	-52	Unknown UART mode get
E_UART_EXTBAUDUNSUP	-53	Extended baudrate is not supported
E_PBTN_NOTOPEN	-70	The push button is not opened

Platform Information

Moxa platform info library is used to get information of interfaces on the device, which is useful to know the device's capability before developing applications.

Usage

- Install the package "libmoxa-platform-info-dev"
  ("libjson-c-dev" package will be installed automatically when install "libmoxa-platform-info-dev")

```
moxa@Moxa:~$ sudo apt-get install \
    libmoxa-platform-info-dev
```

- Include header <mx_platform_info.h> and <json-c/json.h>
- Link the libraries "-ljson-c" and "-lmx_platform_info" while compiling

API List

Function Prototype	**int mx_get_number_of_interfaces(int *num_of_interfaces);**
Description	Get the number of interfaces supported on the device
Parameters	• num_of_interfaces: a pointer which points to a place for storing output value
Return Value	• 0 on success • negative integers as error number
Example	int num_of_interfaces; mx_get_number_of_interfaces(&num_of_interfaces);

Function Prototype	**int mx_get_platform_interface(char ***profiles);**
Description	Get the interfaces supported on the device
Parameters	• profiles: a pointer which points to a place for storing output value ➢ the list of platform interfaces, in "char **" format. e.g. { "led-control", … }
Return Value	• 0 on success • negative integers as error number

Example	char **profiles;
	mx_get_platform_interface(&profiles);

Function Prototype	**int mx_free_platform_interface(char **profiles);**
Description	Free the memory space of profiles allocated by "mx_free_platform_interface" API
Parameters	• profiles: profiles from "mx_free_platform_interface" API
Return Value	• 0 on success • negative integers as error number
Example	mx_free_platform_interface(profiles);

Function Prototype	**int mx_get_profile(const char *interface, struct json_object **profile);**
Description	Get the profile of target interface
Parameters	• interface: the name of the target interface ➢ "buzzer-control" ➢ "dio-control" ➢ "uart-control" ➢ "led-control" ➢ "push-button" • profile: a pointer which points to a place for storing output value
Return Value	• 0 on success • negative integers as error number

Example	struct json_object *profile;
	mx_get_profile("led-control", &profile);

Buzzer

Moxa buzzer control library can be used to control the buzzer on the device. We provide interfaces for controlling the buzzer to beep for a certain period or keep beeping till it is switched off.

NOTE

- Moxa buzzer control library should be used carefully, the buzzer must be stopped before the process ends. Or the buzzer may beep without control.
- The Moxa buzzer control library is supported only in the UC-8100A-ME-T Series.

Usage

- Need package "libmoxa-buzzer-control-dev"

```
moxa@Moxa:~$ sudo apt-get install \
    libmoxa-buzzer-control-dev
```

- Include header <mx_buzzer.h>
- Link library "-lmx_buzzer_ctl" while compiling

API List

Function Prototype	**int mx_buzzer_init(void);**
Description	Initialize Moxa buzzer control library
Parameters	N/A
Return Value	• 0 on success • negative integers as error number
Example	mx_buzzer_init();

Function Prototype	int mx_buzzer_play_sound(unsigned long duration);
Description	Play the buzzer
Parameters	• duration: the duration time in seconds ➢ range: 1-60 ➢ 0 for keep beeping
Return Value	• 0 on success • negative integers as error number
Example	mx_buzzer_play_sound(3);

Function Prototype	int mx_buzzer_stop_sound(void);
Description	Stop the buzzer
Parameters	N/A
Return Value	• 0 on success • negative integers as error number
Example	mx_buzzer_stop_sound();

Digital I/O

Moxa DIO control library can be used to control digital I/O interface. Including getting states from Direct Input and Output ports, setting state of Direct Output ports.

Usage

- Need package "libmoxa-dio-control-dev"

```
moxa@Moxa:~$ sudo apt-get install \
    libmoxa-dio-control-dev
```

- Include header <mx_dio.h>
- Link library "-lmx_dio_ctl" while compiling
- Need to call "mx_dio_init" before using other APIs

API List

Function Prototype	int mx_dio_init(void);
Description	Initialize Moxa DIO control library
Parameters	N/A
Return Value	• 0 on success • negative integers as error number
Example	mx_dio_init();

Function Prototype	int mx_dout_set_state(int doport, int state);
Description	Set state for target Direct Output port
Parameters	• doport: target DOUT port number • state: ➢ DIO_STATE_LOW: low ➢ DIO_STATE_HIGH: high
Return Value	• 0 on success • negative integers as error number
Example	mx_dout_set_state(0, DIO_STATE_HIGH);

Function Prototype	**int mx_dout_get_state(int doport, int *state);**
Description	Get state from target Direct Output port
Parameters	• doport: target DOUT port number • state: a pointer which points to a place for storing output value
Return Value	• 0 on success • negative integers as error number

Example	int state;
	mx_dout_get_state(0, &state);

Function Prototype	**int mx_din_get_state(int diport, int *state);**
Description	Get state from target Direct Input port
Parameters	• diport: target DIN port number • state: a pointer which points to a place for storing output value
Return Value	• 0 on success • negative integers as error number

Example	int state;
	mx_din_get_state(0, &state);

Function Prototype	**int mx_din_set_event(int diport, void (*func)(int diport), int mode, unsigned long duration);**
Description	Set an action for an event occurred of target Direct Input port
Parameters	• diport: target DIN port number • func: a function pointer which will be invoked on DIN event detected • mode: DIN event mode ➢ DIN_EVENT_CLEAR ➢ DIN_EVENT_LOW_TO_HIGH ➢ DIN_EVENT_HIGH_TO_LOW ➢ DIN_EVENT_STATE_CHANGE • duration: The during time that the event occurred to trigger action ➢ range: 40 - 3600000 (ms) ➢ 0 means no duration
Return Value	• 0 on success • negative integers as error number

Example	void (*fp)(int);
	mx_din_set_event(0, fp, DIN_EVENT_STATE_CHANGE, 100);

Function Prototype	**int mx_din_get_event(int diport, int *mode, unsigned long *duration);**
Description	Get event setting of target Direct Input port
Parameters	• diport: target DIN port number • mode: a pointer which points to a place for storing output value • duration: a pointer which points to a place for storing output value
Return Value	• 0 on success • negative integers as error number

Example	int mode;
	unsigned long duration;
	mx_din_get_event(0, &mode, &duration);

UART

Moxa UART can be used to set the mode of UART ports and transmit data via UART ports.

Usage

- Need package "libmoxa-uart-control-dev"

```
moxa@Moxa:~$ sudo apt-get install \
    libmoxa-uart-control-dev
```

- Include header <mx_uart.h>
- Link library "-lmx_uart_ctl" while compiling
- Need to call "mx_uart_init" before using other APIs

API List

Function Prototype	**int mx_uart_init(void);**
Description	Initialize Moxa UART control library
Parameters	N/A
Return Value	• 0 on success • negative integers as error number
Example	mx_uart_init();

Function Prototype	**int mx_uart_set_mode(int port, int mode);**
Description	Set mode of target UART port
Parameters	• port: target UART port • mode: ➢ UART_MODE_RS232 ➢ UART_MODE_RS485_2W ➢ UART_MODE_RS422_RS485_4W
Return Value	• 0 on success • negative integers as error number
Example	mx_uart_set_mode(0, UART_MODE_RS232);

Function Prototype	**int mx_uart_get_mode(int port, int *mode);**
Description	Get mode of target UART port
Parameters	• port: target UART port • mode: a pointer for storing output
Return Value	• 0 on success • negative integers as error number

Example	int mode;
	mx_uart_get_mode(0, &mode);

Function Prototype	**int mx_uart_open(int port);**
Description	Open target UART port
Parameters	• port: target UART port
Return Value	• 0 on success • negative integers as error number
Example	mx_uart_open(0);

Function Prototype	**int mx_uart_close(int port);**
Description	Close target UART port
Parameters	• port: target UART port
Return Value	• 0 on success • negative integers as error number
Example	mx_uart_close(0);

Function Prototype	**int mx_uart_read(int port, char *data, size_t count);**
Description	Read data from target UART port
Parameters	• port: target UART port • data: memory location of data to be stored • count: read size
Return Value	• positive integers means size of data read • negative integers as error number

Example	char data[256];
	mx_uart_read(0, data, 256);

Function Prototype	**int mx_uart_write(int port, char *data, size_t count);**
Description	Write data from target UART port
Parameters	• port: target UART port • data: memory location of data to be written • count: write size
Return Value	• positive integers means size of data read • negative integers as error number

Example	char data[256];
	mx_uart_read(0, data, 256);

Function Prototype	**int mx_uart_set_baudrate(int port, int baudrate);**
Description	Set the baudrate of target UART port
Parameters	• port: target UART port • baudrate: The baudrate
Return Value	• 0 on success • negative integers as error number
Example	mx_uart_set_baudrate(0, 115200);

Function Prototype	**int mx_uart_get_baudrate(int port, int *baudrate);**
Description	Get the baudrate of target UART port
Parameters	• port: target UART port • baudrate: a pointer which points to a place for storing output value
Return Value	• 0 on success • negative integers as error number

Example	int baudrate;
	mx_uart_get_baudrate(0, &baudrate);

Function Prototype	**int mx_uart_set_databits(int port, int bits);**
Description	Set the data bits of target UART port
Parameters	• port: target UART port • bits: The data bits
Return Value	• 0 on success • negative integers as error number
Example	mx_uart_set_databits(0, 8);

Function Prototype	**int mx_uart_get_databits(int port, int *bits);**
Description	Get the data bits of target UART port
Parameters	• port: target UART port • bits: a pointer which points to a place for storing output value
Return Value	• 0 on success • negative integers as error number

Example	int bits;
	mx_uart_get_databits(0, &bits);

Function Prototype	**int mx_uart_set_stopbits(int port, int bits);**
Description	Set the stop bits of target UART port
Parameters	• port: target UART port • bits: The stop bits
Return Value	• 0 on success • negative integers as error number
Example	mx_uart_set_stopbits(0, 1);

Function Prototype	**int mx_uart_get_stopbits(int port, int *bits);**
Description	Get the stop bits of target UART port
Parameters	• port: target UART port • bits: a pointer which points to a place for storing output value
Return Value	• 0 on success • negative integers as error number

Example	int bits;
	mx_uart_get_stopbits(0, &bits);

Function Prototype	**int mx_uart_set_parity(int port, int parity);**
Description	Set the parity of target UART port
Parameters	• port: target UART port • parity: The parity
Return Value	• 0 on success • negative integers as error number
Example	mx_uart_set_parity(0, 0);

Function Prototype	**int mx_uart_get_parity(int port, int *parity);**
Description	Get the parity of target UART port
Parameters	• port: target UART port • parity: a pointer which points to a place for storing output value
Return Value	• 0 on success • negative integers as error number

Example	int parity;
	mx_uart_get_parity(0, &parity);

LED

LED APIs can control the LEDs on the device, which can be ON, OFF, or BLINK. LEDs on a device are separated to types and groups. There are 2 types of LED: Signal LED and Programmable LED. Each type may contain several groups, and each group may contain several LEDs.

Usage

- Install package "libmoxa-led-control-dev"

```
moxa@Moxa:~$ sudo apt-get install \
    libmoxa-led-control-dev
```

- Include the header <mx_led.h>
- Link the library "-lmx_led_ctl" while compiling
- Call "mx_led_init" before using other APIs

API List

Function Prototype	**int mx_led_init(void);**
Description	Initialize Moxa LED control library
Parameters	N/A
Return Value	• 0 on success • negative integers as error number
Example	mx_led_init();

Function Prototype	**int mx_led_get_num_of_groups(int led_type, int *num_of_groups);**
Description	Get the number of groups of a LED type
Parameters	• led_type: ➢ LED_TYPE_SIGNAL or LED_TYPE_PROGRAMMABLE • num_of_groups: a pointer which points to a place for storing output value
Return Value	• 0 on success • negative integers as error number

Example	int num_of_groups;
	mx_led_get_num_of_groups(LED_TYPE_SIGNAL, &num_of_groups);

Function Prototype	**int mx_led_get_num_of_leds_per_group(int led_type, int *num_of_leds_per_group);**
Description	Get the number of LEDs per group of a LED type
Parameters	• led_type: ➢ LED_TYPE_SIGNAL or LED_TYPE_PROGRAMMABLE • num_of_leds_per_group: a pointer which points to a place for storing output value
Return Value	• 0 on success • negative integers as error number

Example	int num_of_leds_per_group;
	mx_led_get_num_of_leds_per_group(LED_TYPE_SIGNAL, &num_of_leds_per_group);

Function Prototype	int mx_led_set_brightness(int led_type, int group, int index, int state);
Description	Set LED state on, off, blink
Parameters	• led_type: ➢ LED_TYPE_SIGNAL or LED_TYPE_PROGRAMMABLE • group: group number • index: LED index • state: ➢ LED_STATE_OFF or LED_STATE_ON or LED_STATE_BLINK
Return Value	• 0 on success • negative integers as error number
Example	mx_led_set_brightness(LED_TYPE_PROGRAMMABLE, 1, 1, LED_STATE_ON);

Function Prototype	int mx_led_set_all_off(void);
Description	Set all LED off
Parameters	N/A
Return Value	• 0 on success • negative integers as error number
Example	mx_led_set_all_off();

Function Prototype	int mx_led_set_all_on(void);
Description	Set all LED on
Parameters	N/A
Return Value	• 0 on success • negative integers as error number
Example	mx_led_set_all_on();

Push Button

Push button APIs.

Usage

- Need package "libmoxa-push-button-dev"

```
moxa@Moxa:~$ sudo apt-get install \
    libmoxa-push-button-dev
```

- Include header <mx_pbtn.h>
- Link library "-lmx_push_btn" while compiling
- Need to call "mx_pbtn_init" before using other APIs

NOTE Remember to terminate the push button daemon that run by the system. Or you might accidentally trigger some system functions which defined in the daemon when testing the button.
The push button daemon is called **moxa-pbtnd**. You can terminate the process by using the **`systemctl stop moxa-push-button`** command.

API List

Function Prototype	**int mx_pbtn_init(void);**
Description	Initialize Moxa push button library
Parameters	N/A
Return Value	• 0 on success • negative integers as error number
Example	mx_pbtn_init();

Function Prototype	**int mx_pbtn_open(int type, int index);**
Description	Open a push button by button type and index
Parameters	• type: ➢ BUTTON_TYPE_SYSTEM or BUTTON_TYPE_USER • index: button index
Return Value	• negative integers as error number • 0 or positive integer: button ID for manipulate the button by other APIs

Example	int btn_id;
	btn_id = mx_pbtn_open(BUTTON_TYPE_USER, 1);

Function Prototype	**int mx_pbtn_close(int btn_id);**
Description	Close a push button
Parameters	• btn_id: button ID returned by "mx_pbtn_open"
Return Value	• 0 on success • negative integers as error number
Example	mx_pbtn_close(0);

Function Prototype	**int mx_pbtn_start(int btn_id);**
Description	Start listening on a push button
Parameters	• btn_id: button ID returned by "mx_pbtn_open"
Return Value	• 0 on success • negative integers as error number
Example	mx_pbtn_start(0);

Function Prototype	**int mx_pbtn_stop(int btn_id);**
Description	Stop listening on a push button
Parameters	• btn_id: button ID returned by "mx_pbtn_open"
Return Value	• 0 on success • negative integers as error number
Example	mx_pbtn_stop(0);

Function Prototype	**int mx_pbtn_wait(void);**
Description	Check if there is any button being listened on, if so, hang the process. This API can be used for daemon.
Parameters	N/A
Return Value	• 0 on success • negative integers as error number
Example	mx_pbtn_wait();

Function Prototype	**int mx_pbtn_is_pressed(int btn_id);**
Description	Get the state of a button
Parameters	• btn_id: button ID returned by "mx_pbtn_open"
Return Value	• negative integers as error number • 0 if the button is released • 1 if the button is pressed
Example	mx_pbtn_is_pressed(0);

Function Prototype	**int mx_pbtn_pressed_event(int btn_id, void (*func)(int));**
Description	Register action on button pressed
Parameters	• btn_id: button ID returned by "mx_pbtn_open" • func: a function pointer which will be invoked on button pressed
Return Value	• 0 on success • negative integers as error number

Example	void (*fp)(int);
	mx_pbtn_pressed_event(0, fp);

Function Prototype	**int mx_pbtn_released_event(int btn_id, void (*func)(int));**
Description	Register action on button released
Parameters	• btn_id: button ID returned by "mx_pbtn_open" • func: a function pointer which will be invoked on button released
Return Value	• 0 on success • negative integers as error number

Example	void (*fp)(int);
	mx_pbtn_released_event(0, fp);

Function Prototype	**int mx_pbtn_hold_event(int btn_id, void (*func)(int), unsigned long duration);**
Description	Register action on button hold
Parameters	• btn_id: button ID returned by "mx_pbtn_open" • func: a function pointer which will be invoked on button hold • duration: the time that button being hold to trigger action (in seconds) ➢ range: 1-3600 ➢ 0 for keep triggering every second
Return Value	• 0 on success • negative integers as error number

Example	void (*fp)(int);
	mx_pbtn_hold_event(0, fp, 60);